fertigations. Clogging ratio, under normal conditions using well water, was 5:1 (8.0%:1.5%) between drippers and jets at the experimental grove.

5. Certain precautions with the compatability of different fertilizer compounds should be observed during fertigation operations. Magnesium is one of the more difficult elements to dissolve in solution. Magnesium nitrate, while a satisfactory source of Mg, cannot be used in presence of P and NH_3 or it will react to form insoluble magnesium ammonium phosphate and will clog irrigation equipment.

The pH of the water for fertigation should be considered when P is used as water with high alkalinity will react with P to form insoluble tribasic calcium phosphate which will clog irrigation equipment (8). Therefore, the pH of solutions discharging from sprinklers or emitters should be monitored where P is involved.

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PATHOGENICITY OF FUSARIUM SOLANI TO CITRUS ROOTS AND ITS POSSIBLE ROLE IN BLIGHT ETIOLOGY[1,2]

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Abstract. **Studies of root systems on blight trees have shown that** Fusarium solani **is associated with a fibrous root rot on such trees. Citrus rootstock seedlings inoculated with pathogenic trains of** F. solani **cultured from wood of diseased roots developed the same kind of root-rot symptoms. Aboveground symptoms first appeared as a leaf roll and wilt; leaf color became a dull green as they dehydrated; and final leaf symptoms were a severe wilt, followed by desiccation and some leaf drop. Early leaf symptoms occurred after the fungus had invaded the root cortex but before it had fully colonized the water-conducting wood. After the wood became infected, vessel plugging developed in the roots and stem. No rootstock seedlings were resistant to infection, but some displayed a tolerance to wilt. Fungus strain variability ranged from nonpathogenic to highly pathogenic types. Pathogenic variability of the fungus may be related to its capacity to produce biologically active metabolites. In the field, vessels in trunks and in infected fibrous roots on blight trees were also plugged.**

Fusaria are soil fungi that cause various vascular wilts and root and stem rots of cultivated plants (3, 10). Studies have shown that Fusaria can be pathogenic on citrus alone, in combination with a primary parasite, and when environmental conditions are created to favor the fungus versus the host (1, 6, 22, 23, 29, 32). Although *Fusarium solani* (Mart.) Appel and Wr. emed. Snyd. and Hans. is a common inhabitant around citrus roots in Florida (19), it and others have acquired the reputation among most researchers of being no more than saprophytes on citrus roots in Florida. This reputation is due partly to early studies on the cause of spreading decline and blight. Sherbakoff, studying spreading decline (26), and Rhoads (25) and Childs (7), studying blight, were unsuccessful in showing that the Fusaria they used were pathogenic on citrus. In later studies on blight, Cohen (8) dismissed fungi because soil microbial populations of blight and healthy trees did not differ. More recently, Hanks and Feldman (13) concluded that fungi do not appear to be directly involved as the causal agent of young tree decline (blight). Furthermore, soil fungi (including Fusaria) have been essentially ruled out as causes of blight because researchers have reported no apparent difference in the condition of roots on blight and healthy trees (8, 24, 27, 28), especially on trees with early symptoms (8, 11, 24). Knorr (16) summarized the importance of *Fusarium* spp. on citrus by stating that though they may be present in many parts of citrus trees, they are not considered primary pathogens.

These attitudes about blight and its relationship to soils and soil fungi are changing. More recent studies have shown that *F. solani* is the primary *Fusarium* colonizing citrus fibrous roots, that it is associated with root-rot symptoms on blight trees, and that it can be pathogenic on citrus roots (20). Its potential role in blight is complemented by studies and observations which indicate that blight is related to soils and soil edaphic factors (9, 18, 25). Also, amino acid patterns in roots (12) and results of root-pruning healthy trees (2) suggest the root as the origin of stress on the tree.

This report describes some of the pathogenic characteristics of *F. solani* on citrus seedlings, the reaction of seedlings and budded plants to infection, and the toxigenic effects of naphthazarins (produced by *F. solani*) to germinating seed.

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

Materials and Methods

Most strains of *F. solani* used in the tests reported here were cultured from wood (xylem) of fibrous roots from blight trees with root-rot symptoms. Several strains of *F. solani* from citrus with dry root-rot symptoms in California were compared with Florida strains in one experiment. Inoculum was produced by growing the cultures on Fries medium containing agar for 5 to 6 days and scraping off the conidia in water, or by growing them, with shaking, in a liquid Fries (30) medium for 4 to 5 days. Cultures were maintained on Fries agar medium, but were transferred to potato dextrose agar in test tubes to observe the production of red-pigmented naphthazarin toxins. Identities of Florida cultures are abbreviated so that F, the first letter, indicates the State of Florida, the second letter designates the grove source, and the third letter the culture number.

Greenhouse-grown rootstock seedlings and a few rough lemon seedlings (*Citrus limon* (L.) Burm. f.) budded with *C. sinensis* (L.) Osbeck vars. 'Valencia' and 'Hamlin' scions were used in the inoculation tests. None of the root systems of these plants were intentionally cut to simulate injury. With the exception of the first experiment, in which various inoculation techniques were compared, all seedling rootstocks were inoculated by dipping the root systems in the liquid Fries culture for 5 minutes. Control plants were dipped in uninoculated media. All plants were potted in steam-pasteurized Astatula find sand subsoil (hyperthermic, uncoated typic quartzipsamments, 94-97% sand, 0.25% organic matter) in 15-cm clay pots. After potting, all plants were fertilized with a dilute liquid 12-6-6, with nitrogen in the form of urea.

Data were collected on wilt, root-rot, fungus infection, and degree of vessel plugging. Wilt and root-rot symptoms were rated on a scale of 0 to 5, where 0 represented no evident above- or below-ground symptoms, and 5 indicated a wilted plant near death or a root system extensively rotted because of infection. Roots were evaluated for infection and vessel plugging by chopping a root system into 1-cm-long pieces and staining them in hot acid fuchsin or aniline blue in lactophenol. They were destained in lactophenol, and 30 pieces per pot were mounted on glass slides and examined microscopically. Chlamydospore numbers were used to indicate relative infection on a scale of 0-3, where 0 indicated none, 1 = 1-50, 2 = 51-100, and 3 = 100+. Vessel plugging was rated on the same scale, where 0 = none and 3 was used to indicate extensive plugging. In certain tests with citrus rootstocks, stem pieces 2.5 cm long were cut from the plant at the ground line, and longitudinal sections cut on a sliding microtome to examine plugging. Vessel plugging was rated as either positive or negative in three thin sections examined per plant.

Naphthazarins are a class of toxins produced by *F. solani*. They were extracted from culture filtrates as previously described (4) to determine their toxicity to rough lemon seed. Naphthazarins were dissolved in 2.5 ml acetone and added to sterile Whatman No. 1 filter paper discs in petri dishes. Solvent was removed from the discs in a sterile laminar flow hood. After drying, each disc was wetted with 2.5 ml sterile water, and 10 surface-disinfested Estes rough lemon seed were placed on each disc. After 13 days in the dark at 27°C, seeds were rated for number of germinating embryos, total root growth, and number of embryos with branching roots.

Results

The first apparent symptom in plants reported in Table 1 was a leaf roll in the 2 root dip treatments, 2 to 3 days after inoculation. The leaf roll later disappeared from the plants dipped in conidia, but progressed to a wilt on plants dipped in Fries media cultures. Wilted leaves became flaccid, and appeared dull and darker green (Fig. 1A). Some leaves later became desiccated and abscised. Root rot, the symptom of infected roots, was most severe on plants in the Fries root dip (Fig. 2). Sixteen days after inoculation, at the termination of the test, new root and shoot growth was present only on plants in the soil infestation and the conidial spray treatments. Low levels of root infection had not prevented plant recovery. Leaves sprayed with conidia did not develop lesions or other symptoms indicative of infection.

Of the rootstocks inoculated with *F. solani*, Key lime (*C. aurantiifolia* (Christm.) Swingle), and *C. macrophylla* Wester were the most tolerant to root rot and wilt. There was no significant difference in wilt reaction among Cleopatra (Cleo) mandarin (*C. reticulata* Blanco), rough lemon, sour orange (*C. aurantium* L.), and Carrizo citrange (*Poncirus trifoliata* (L.) Raf. X *C. sinensis* (L.) Osb.). A trace of root rot developed on some controls, but that is not uncommon if roots are temporarily water-logged or injured in some way (Table 2). Both the 'Hamlin' and 'Valencia' scions on rough lemon inoculated with the F-M-1 culture developed wilt symptoms like those of the rootstock alone (Fig. 1B). The controls did not exhibit wilt.

Six rough lemon, one Key lime, and no *C. macrophylla* inoculated with culture F-M-1 contained vessel plugging in the stem; only one control, a Key lime, of this group contained vessel plugs. Four rough lemon, one Key lime, and two Carrizo citrange plants inoculated with F-G-1

Table 1. Leaf wilt and root-rot responses in rough lemon seedlings inoculated with *Fusarium solani* by various techniques.

Treatment	Fungus cultures and disease symptoms					
	F-M-1		F-G-1		Control	
	(Ratio, wilted/ inoculated)	Root rot[z]	(Ratio, wilted/ inoculated)	Root rot[z]	(Ratio, wilted/ inoculated)	Root rot[z]
1. Root dip in inoculated Fries medium	5/7	4.29	2/7	3.14	0/7	0.00
2. Root dip in aqueous conidial suspension[y]	0/7	1.29	0/7	1.00	0/7	0.00
3. Soil injected with conidia[x]	0/7	0.14	0/7	0.14	0/7	0.14
4. Soil mixed with conidia[w]	0/7	0.29	0/7	0.14	0/7	0.00
5. Soil drenched with conidia[x]	0/7	0.29	0/7	0.43	0/7	0.00
6. Leaves sprayed with conidia[v]	0/7	0.00	0/7	0.00	0/7	0.00

[z]Root-rot rating 0-5; zero indicates no symptoms, 5 indicates extensive epidermal and cortical sloughing.
[y]5-min root dip in F-M-1 (800,000 conidia/ml) and F-G-1 (2,810,000 conidia/ml) cultures of *F. solani*.
[x]10 ml of each *Fusarium* culture added per pot at concns indicated in [y] (above).
[w]20 ml of each *Fusarium* culture mixed with soil per pot at concns indicated in [y].
[v]5 ml of each *Fusarium* culture sprayed on leaves of each plant at concns in [y]. Sprayed plants were covered with plastic bags for 24 hr after inoculation to maintain a high relative humidity.

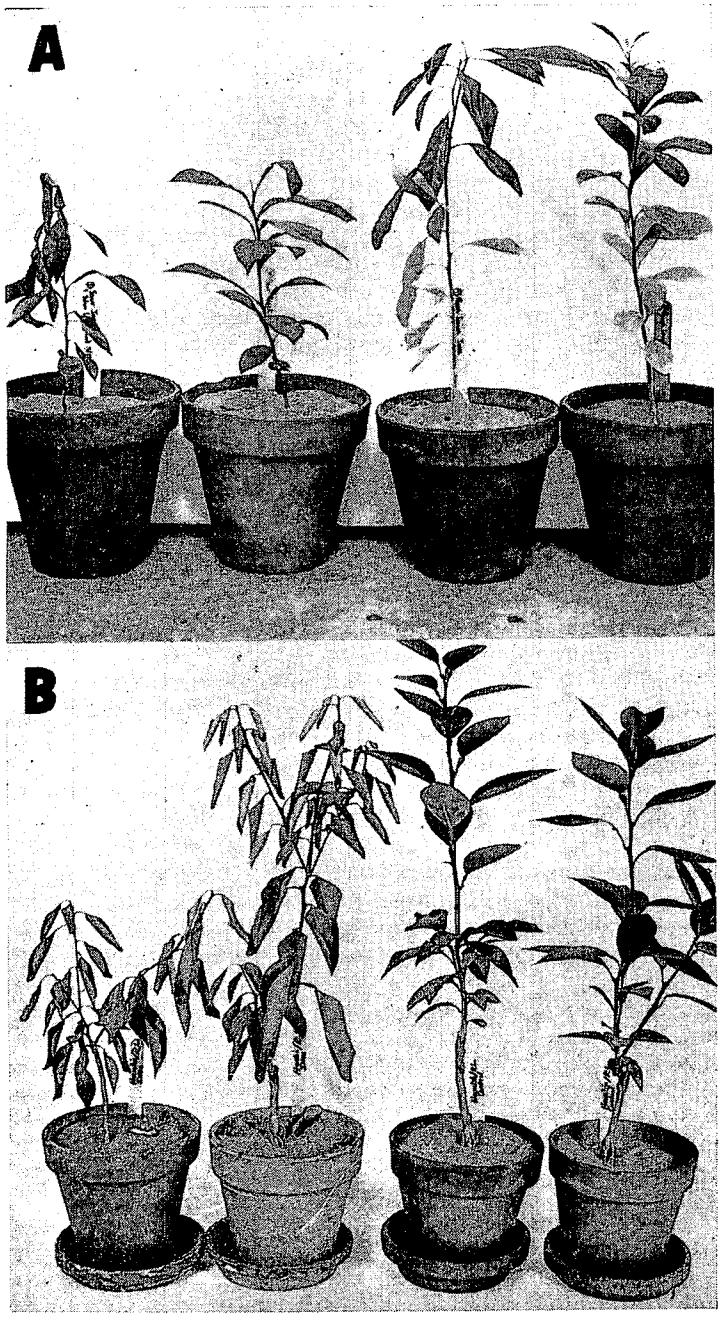

Fig. 1. A. Left to right, wilted sour orange seedling inoculated with *Fusarium solani*, control, wilted/inoculated rough lemon seedling, and control. B. Left to right, two 'Hamlin' scions budded on rough lemon exhibiting wilt symptoms after inoculation, and two healthy controls.

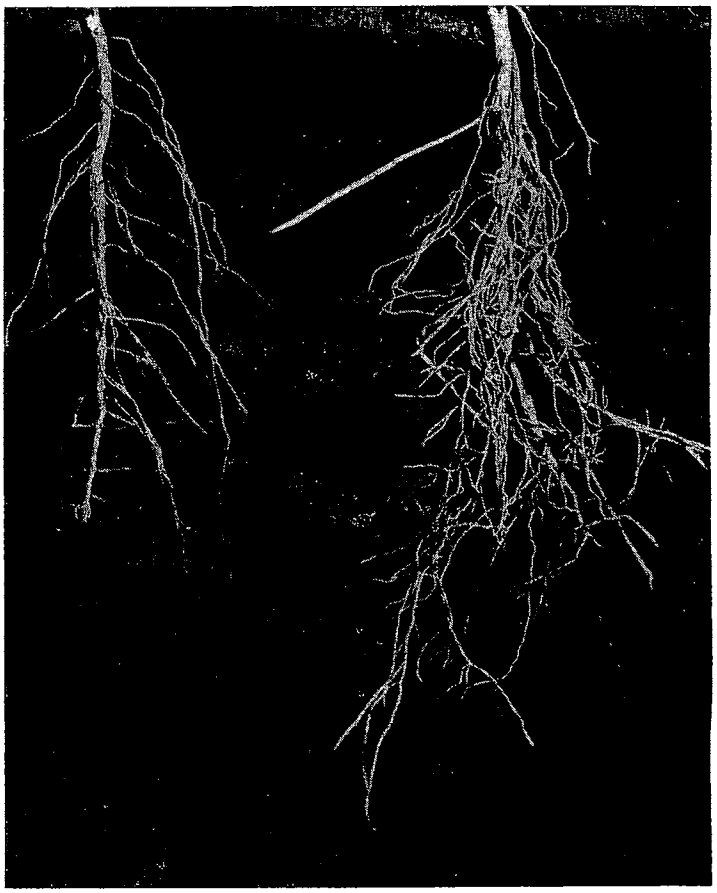

Fig. 2. Left, rough lemon root system inoculated with *Fusarium solani* exhibiting cortical and epidermal sloughing, symptoms of root rot; right, uninoculated control root system.

contained vessel plugs. None of the other rootstocks inoculated with F-G-1, nor any of the controls, contained vessel plugs. Vessel plugging appeared to be primarily the resin type.

The California *F. solani* cultures were similar in morphology to the Florida cultures. Dry root rot is a disease complex involving infection by *F. solani* (J. Menge, personal communication). Although the California *F. solani* cultures were apparently more pathogenic than the Florida cultures used, all cultures behaved similarly in the plant (Table 3). The pathogenicity of the Florida strains was probably diminished by their lengthy retention in culture. As in the stem, vessel plugging in the root was a response to infection.

At the end of 1 week, *F. solani* infection in the cortex was extensive, but only moderate in the wood (Table 4).

Table 2. Response of six citrus rootstocks inoculated with three cultures of *Fusarium solani*.[z]

	F-M-1				F-L-1				F-G-1			
	Inoc.		Control		Inoc.		Control		Inoc.		Control	
Rootstock	Wilt	Root rot	Wilt	Root rot	Wilt	Root rot	Wilt	Root rot	Wilt	Root rot	Wilt	Root rot
Cleopatra mandarin	3.7 a	4.0 a	0.0	0.3	2.0 a	3.6 a	0.0	0.6	2.3 a	1.9 ab	0.0	0.0
Rough lemon	3.0 a	2.6 b	0.0	1.0	0.0 b	3.0 ab	0.0	2.0	2.0 a	1.3 b	0.1	0.0
Sour orange	4.3 a	3.6 ab	0.0	0.1	0.7 ab	4.1 a	0.0	1.1	2.7 a	1.9 ab	0.0	0.3
Key lime	0.0 b	2.6 b	0.0	0.0	0.0 b	1.9 b	0.0	1.0	0.1 b	1.5 ab	0.0	0.0
Citrus macrophylla	0.4 b	2.9 ab	0.0	0.0	0.0 b	2.0 b	0.0	0.6	0.0 b	1.0 b	0.0	0.0
Carrizo citrange	2.9 a	3.3 ab	0.0	0.6	1.0 ab	2.9 ab	0.0	0.6	1.3 ab	2.7 a	0.0	0.3

[z]Wilt and root rot rated on a scale of 0-5. 0 = no wilt and root-rot symptoms, with severity of symptoms increasing to a 5 indicating wilted leaves have become desiccated, and fibrous roots exhibit extensive epidermal and cortical sloughing. Rootstock values followed by the same letter or group of letters within columns do not differ significantly from one another at P = 0.05. All values are means of 7 single plant replicates.

Table 3. Wilt, root rot, stem and root infection, and vessel plugging in Cleopatra mandarin and rough lemon seedlings 9 days after inoculation with Florida and California cultures of *Fusarium solani*.

Fusarium cultures	Cleopatra mandarin						Rough lemon					
	Wilt[z]	Root[z] rot	Stem infection[y] (ratio, infected/ inoculated)	Root infection and vessel plugging[x] Cortex	Stele	Vessel plugs	Wilt[z]	Root[z] rot	Stem infection[y] (ratio, infected/ inoculated)	Root infection and vessel plugging[x] Cortex	Stele	Vessel plugs
Florida F-K-3	0.4	2.0	1/5	—	—	—	0.2	1.8	1/5	—	—	—
Florida, F-S-1	2.0	2.2	3/5	2.2	1.3	0.09	0.4	2.2	5/5	1.5	0.5	0.00
Calif., 118	2.6	2.4	3/5	—	—	—	1.2	1.8	3/5	—	—	—
Calif., 119	3.4	4.8	1/5	1.4	0.6	0.01	1.4	3.0	4/5	1.4	0.6	0.01
Calif., 127	2.2	4.6	3/5	1.6	0.6	0.00	1.2	4.4	4/5	1.5	0.3	0.00
Control	0.0	0.4	0/5	0.0	0.0	0.00	0.0	0.2	0/5	0.0	0.0	0.00

[z]Wilt and root rot rated on a scale of 0-5; zero indicates no wilt and root rot symptoms; severity of symptoms increased from a 1 to a 5, which indicated wilted leaves had become desiccated and extensive epidermal and cortical sloughing were present in fibrous roots.
[y]Two pieces of stem per plant cut at the ground line were plated on potato-dextrose-agar to detect infection.
[x]*Fusarium* infection and vessel plugging rating scales: 0 = no infection or plugging, to 3 = heavy infection based on chlamydospore number or extensive vessel plugs.

Visually, it reached a maximum in the wood by the third week, but the decline afterward was due to the difficulty in evaluating infection because of the decrease in stain accumulated by the aged chlamydospores. Vessel plugging was first detected the second week and gradually increased to the end of the test, but remained low.

Table 4. Incidence of *Fusarium solani* infection and vessel plugging in roots of rough lemon seedlings at weekly intervals after inoculation.[z]

Weeks after inoculation	*F. solani* chlamydospores in cortex	*F. solani* chlamydospores in wood	Vessel plugging
1	2.98	1.75	0.00
2	—	1.76	0.32
3	—	2.60	0.29
4	—	2.17	0.36
5	—	1.60	0.57
Control	0.00	0.00	0.00

[z]Five replicate pots examined each week. *F. solani* infection and vessel-plugging rating scales: 0 = no infection or plugging, to 3 = heavy infection based on chlamydospore number or extensive vessel plugs.

Regardless of whether *F. solani* produced red naphthazarin toxins or apparently none, cultures of both types infected and caused wilt in rough lemon seedlings (Table 5). Of the 3 naphthazarins tested, fusarubin was the most toxic, reducing growth to 39% of control values (Table 6). Toxins appeared to have no effect on the number of embryos that germinated and only a slight effect on the number of roots that branched. The concentration of naphthazarins to which a root may be exposed when colonized by *F. solani*

Table 6. Effects of naphthazarin toxins from *Fusarium solani* on germinating rough lemon seed.

Toxin	Concn (ppm)	Root growth[z] (% of control)	Germination responses: No. of branching roots/10 seeds	Germination responses: No. germinating embryos/10 seeds
Fusarubin	100	38 a	2.5	15.5
Fusarubin	50	60 a	4.5	16.5
Javanicin	100	62 a	4.5	20.0
Javanicin	50	85 b	5.5	14.0
Anhydrofusarubin	100	59 a	3.5	15.5
Anhydrofusarubin	50	82 b	3.5	19.0
Control	—	100	4.8	15.5

[z]Root growth values followed by the letter "a" differ significantly from control value at P = 0.01, using the least significant difference test for variable replication; those values followed by "b" are not significant.
All values represent the mean of two tests.

Table 5. Wilt reaction in rough lemon seedlings inoculated with naphthazarin toxin-producing cultures (red pigmentation) and nonpigmented cultures of *Fusarium solani*.[z]

Test No. 1: *F. solani* cultures and pigmentation	Ratio, wilted/inoculated	Wilt rating	Test No. 2: *F. solani* cultures and pigmentation	Ratio wilted/inoculated	Wilt rating
F-G-1, red	5/5	3.0	F-F-1, red	0/5	0.0
F-G-2, red	5/5	3.4	F-F-3, red	0/5	0.0
F-G-3, red	5/5	4.0	F-K-2, red	0/5	0.0
F-G-4, red	5/5	3.8	F-G-11, red	0/5	0.0
F-G-5, red	5/5	4.6	F-G-12, red	0/5	0.0
F-G-14, red	5/5	4.4	F-G-13, red	0/5	0.0
F-G-20, clear	4/5	0.8	F-M-2, clear	0/5	0.0
F-G-21, clear	0/5	0.0	F-M-4, clear	0/5	0.0
F-G-22, clear	5/5	2.0	F-K-1, clear	0/5	0.0
F-G-23, clear	2/5	1.4	F-F-2, clear	1/5	0.2
F-G-24, clear	5/5	2.8	F-L-2, clear	5/5	3.2
F-G-25, clear	3/5	1.8	F-B-1, clear	3/5	1.8
Control	0/5	0.0	Control	0/5	0.0

[z]Presence of pigmentation observed in cultures grown on potato-dextrose-agar. Wilt rated on a scale of 0-5; zero indicates no symptoms — to 5, which indicates wilted leaves have become desiccated.

is not known. However, the concentration of these toxins in filtrates of *F. solani* cultures may exceed 200 ppm (15) and, in mycelia, may reach 4,500 ppm (14).

Discussion

In the field, *Fusarium solani* is a soil-borne fungus generally associated with root and stem rots on cultivated plants. Ordinarily, it is considered a weak parasite, not inciting enough disease to seriously affect the host; under adverse plant-growing conditions, however, infection becomes more extensive, resulting in more damage to the host. *Fusarium solani* can readily cause decay of young, undamaged roots on weakened hosts (10) or infect roots already injured by some other cause. Its association with diseases affected by environmental stress have labeled *F. solani* as a stress parasite. The most pronounced effects of damage caused by *F. solani* and other facultative parasites occur when plants are predisposed by water stress. Excess water alone is seldom a predisposing factor in plant disease. Of more serious consequence to the host are internal water deficits arising from excess water loss by transpiration, reduced water uptake, or a combination of both (31).

The impact of edaphic factors on the plant and fungus has made it difficult to study infection and disease under greenhouse conditions. In our experiments, although no intended stress was imposed on the plants, they did go through the shock of transplanting and this may have helped predispose plants to infection, especially during the hottest part of the day when moisture demand by the leaves was not met by the recently disturbed roots. Schoeneweiss (31) contends that plant water stress is a main component of transplanting shock. Best infection occurred in the 2 treatments where the fungus was brought in close contact with the root. This suggests that a high inoculum load, together with an appropriate nutrient supply, maximizes infection.

This study has clearly demonstrated that *F. solani* is pathogenic on citrus roots, resulting in wilting and sometimes death of the plant. Root-rot symptoms resemble those occurring on roots of trees in blight groves. The possible relationship of *F. solani* as a cause of blight becomes more tenable with this knowledge. The diverse pathogenic variability of this fungus may explain the pattern of tree loss on good growing sites, as well as those that have been more subject to blight (9, 18, 25). In well-drained sites where trees are not normally subject to water stress, the more-virulent forms of the fungus may become established and operative. In contrast, on poorly drained soils and those over a pan, even the weakly parasitic strains may be active enough to weaken the plant. Also, with cultural practices that are injurious to the root, *F. solani* can assume its role as a stress parasite or pathogen of opportunity.

Healthy trees also exhibit symptoms of root rot (20), thus *F. solani* infection precedes aboveground symptoms by some period of time. Sufficient root damage and internal vessel plugging needed to cause aboveground blight symptoms may be the effect of a cumulative series of infections resulting from periodic moisture stress. In our greenhouse studies, some plants wilted by a single inoculation eventually recovered and grew normally; thus, in the field, more than one attack may be necessary. However, if the population shifts to a highly pathogenic one in the field, fewer attacks may be needed to cause disease symptoms.

In these and other experiments we have done, irreversible wilt symptoms developed as early as 24 hours and always by the third or fourth day after inoculation. Disruption of waterflow this early does not appear to be solely related to the water-conducting wood which, even a week to 9 days after infection (Tables 3 and 4), was poorly colonized and contained few plugs. Results from Tables 3 and 4 also indicate that the cortex is the first root tissue to be heavily infected and destroyed. Infection in roots in the field followed the same pattern (21). Wilt development in seedlings inoculated with *F. solani* cultures, which apparently do not produce naphthazarins (Table 5), implied that other fungus metabolites may play an early role in wilt development. The destruction of the cortex by fungus pectinases and cellulases would disrupt the pathway of waterflow into the root. These cultures may also produce the mycotoxic 12, 13,-epoxy-trichothecenes, which are known to have phytotoxic properties (5). Naphthazarins may affect the host metabolism later in the infection cycle, perhaps by stimulating vessel plugging locally or systemically after the wood is well colonized.

Vessel plugging in the stem and roots in this study developed as a response to infection; therefore, it is likely that increased vessel plugging in *F. solani*-infected roots on blight trees formed in the same way (20). Thus, the increase in vessel plugging in roots and aboveground parts of blight trees (17) could very well be due to the effects of cumulative attacks by *F. solani*. Vascular occlusions are a common host response to pathogen invasion.

Only two of six rootstocks exhibited characteristics of resistance to *F. solani*. It is possible that differences in resistance to blight apparent between the other rootstocks in the field do not appear readily in the seedling stage.

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AN IMPROVED SATELLITE FROST WARNING SYSTEM[1]

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Abstract. **The Satellite Frost Forecast System (SFFS) is quite different from the one that IFAS initiated with NASA support 3 years ago. The system now entering the final stages of development is highly automated. Acquisition of satellite data from computer controlled files near Washington, D.C. is handled automatically by a Hewlett-Packard minicomputer, the heart of the system. That computer also calls through an automated telephone link and records the data from 10 key stations scattered over Florida. Microprocessors at the 10 key stations answer the telephone, interrogate wind, temperature and radiation sensors, and send the data to the calling computer without human intervention. A block diagram of the elements of the improved SFFS is shown and recent changes described.**

Products of the SFFS have until recently been viewed in real time only by forecasters at the National Weather Service forecast office in Ruskin and by the developers. Now, an experimental link with two County Extension Centers is being developed to explore solutions to problems as they are identified. Since the first concepts of SFFS were developed, it has been the goal of the developers to communicate, or to aid in the communication of, SFFS products to individual users of such information. The 1980-81 frost season should usher in the first quantum jump in the number of real time users of the SFFS products. The second jump is yet to be determined but may rest upon development of the IFAS Computer Network. This network has a 3 year completion timetable starting in late 1980.

Finally, ability of the SFFS to forecast several hours in advance what the satellite will sense rests on a physical model that forecasts future temperatures at the key stations and a space model that spreads these forecasts out into a predicted satellite view. Refinements of these models continue. As NOAA/NWS takes over the SFFS in 1981 (tentative plan), refinement of the models will probably continue in IFAS/Climatology at the University of Florida in Gainesville.

During the 3.5 years of development, SFFS has undergone numerous changes, several of which have been relatively extensive (1, 2, 3, 4, 7). Some have occurred recently and substantially improved the system. The purpose of this paper is to describe the current system and allude to how recent refinements have improved it. Most of the system changes have been responses to a rapidly changing field of computerized communications. Recent technological advances have given SFFS developers opportunities to improve the system while solving some of the problems such as these that the use of earlier versions revealed.

System Back-up. SFFS was described briefly to FSHS members in both the 1978 and the 1979 meetings (2, 4). Some appreciation for the changes that the system has undergone can be developed by reviewing those articles.

SFFS performs 2 major functions. One is the acquisition of data and the other is extrapolation of those data into the future. The system acquires both satellite and ground weather data to use in building both current and future false color thermal maps. Its functions, therefore, are both acquisition and prediction (forecasting). While it accomplishes these missions in automated fashion, it falls short of a completely automated system (so-called push-button system). The major reason it is not completely automated is substantial flexibility has been built into the system in regard to how it handles the prediction and data presentation functions.

A block diagram of the current system is shown in Figure 1. Notice there are 2 minicomputers at the heart of the system; one at the NWS weather office at Ruskin and the other at IFAS/Climatology in Gainesville. A double-headed arrow between the two computers indicates a telephone link between them through which back-up is to be provided. Other arrows in Figure 1 indicate the several telephone links over which the SFFS acquires and disseminates data.

Satellite data are acquired from NOAA/NESS through a NOAA/NWS link near Washington, D.C. The satellite

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