Soil Fungi and Seedling Growth

citrus tree growth and soil population relationships being studied in series of greenhouse tests underway at Riverside

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Most soil borne plant parasites grow more vigorously in soil freed of competing organisms by previous sterilization than in natural soils where they have to compete with other organisms. Some of the competing organisms are antagonistic to the parasites and tend to suppress the activity of the detrimental forms.

Various crop rotations, green manure crops, or additions of organic materials to the soil will sometimes aid in the control of certain plant root diseases. It is believed that the organic matter stimulates the development of a soil population which is antagonistic to the root parasites.

When some soils are inoculated with root parasites the organisms survive and cause considerable damage while in other soils the same organisms will largely die out and will cause little or no root injury. It is thought that the kinds of organisms present in the soil will greatly influence the establishment of new species. If a certain microbial population tends to resist the establishment of plant root parasites in a particular soil, then presumably this action will be reflected in improved plant growth.

Greenhouse Studies

Greenhouse studies were started at Riverside in an attempt to learn more about soil population–citrus tree growth relationships. Nearly all of the studies have dealt with the soil fungi. For these tests various fungi found in citrus soils were established in the soil alone and in various combinations.

To establish a particular mold—fungus—the soil is first fumigated with propylene oxide to kill the existing fungi. It is then spread out to allow dissipation of the fumigant. Then the soil is inoculated with the desired species of fungi as it is put into pots. Most of the species tested could be established by this technique.

Once established a particular species tended to resist establishment of other species for extended periods. Even after months the fungus population in some soils apparently consisted only of those used for inoculation, but in other soils additional species gradually became established.

Approximately 30 common soil fungi have been tested with respect to their influence on growth of citrus seedlings. Most of these species have exerted little or no influence on growth of a first—eight months—crop of seedlings. However, a strain of *Fusarium oxysporum* and *Pythium ultimum* reduced growth slightly in one or more soils. When *Thielaviopsis basicola* was established it greatly reduced growth in several soils. When the latter fungus was forced to compete with certain other fungi, growth retardation was less, but with still other species no improvement over *T. basicola* alone was evident. An example of growth data for these studies is given in this table:

Effect of Certain Soil Fungi on Growth of Sweet Orange Seedlings in Holtville Silty Clay Loam

Soil treatment	Dry weight of tops
	g.
None	6
Fumigated	26
Fumigated and inoculated with:	
Stemphylium piriforme	25
Pythium ultimum	20
Thielaviopsis basicola	6
T. Basicola and Penicillium funiculosam	7
T. Basicola and Penicillium nigricans	14

If the various fungi tested—other than *Thielaviopsis basicola*—retarded the development of detrimental microbes in the soil then the growth period was not long enough to reflect such action in total plant growth. Perhaps a longer growing period or other species may have altered the results. It is also possible that the reduced growth effect of a first crop of seedlings on a second crop may be influenced by the nature of fungus population of the soil. The data given in the larger table suggest that this may be true. In the original old citrus soil the first crop of seedlings reduced the growth of the second crop by 36%, while growth in the fumigated soil was only reduced 11%. The fumigation treatment causes a marked change in the microbial population of the soil.

Effect of Fumigation and Various Soil Fungi on Growth of a First and Second Crop of Sweet Orange Seedlings in Old Citrus Yolo Sandy Loam

Soil treatment	Relative growth* 1st crop	Relative growth* 2nd crop	Reduced growth**
	%	%	%
None (check)	50	32	36
Fumigated	82	73	11
Fumigated and inoculated with:			
Cunninghamella echinulata	95	82	15
Fusarium sp.	82	63	24
Cyclindrocarpon radicicola	86	68	21
Gliocladium penicilloides	89	91	0
Trichoderma viride	92	95	0
Fusarium solani & *Thielaviopsis basicola*	92	41	56

* Assuming first crop of seedlings in a non-citrus check soil = to 100.

** Reduced growth effect of first crop of seedlings on second crop.

In the fumigated soils in which *Gliocladium penicilloides* or *Trichoderma viride* were established the second crop grew just as well as the first crop. *Thielaviposis basicola* survived but did not grow vigorously during the first cropping of the fumigated soil inoculated with this fungus and *Fusarium solani.* It also did not reduce growth of the first crop of seedlings. During the growth period of the second crop, however, it increased in concentration and apparently was responsible for a growth reduction of 56%.

These studies indicate that the fungus population of the soil can vary greatly without significantly influencing growth of a first crop of citrus seedlings in three gallon pots in the greenhouse. Most species tested exerted little or no effect on growth. Under the conditions of the study, however, one species, *Thielaviopsis basicola,* greatly reduced growth when it was established in the soil. The magnitude of the reduced growth caused by this fungus was found to be influenced by the kinds and activity of associated fungi.

The nature of the fungus population of the soil influenced the magnitude of the reduced growth effect of one crop of citrus seedlings on a second crop.

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The above progress report is based on Research Project No. 1377.