4. Graetz, K. E. 1973. Seaside plants of the Carolinas. Univ. North Carolina, Sea Grant Publication UNC-S6-73-06.
5. Morton, J. F. 1973. Salt Tolerant Silt grass (Paspalum vaginatum). Proc. Fla. State Hort. Soc. 86:482-499.
6. U.S. Army Corps of Engineers, South Atlantic Division 1973. South Atlantic—Gulf Region, Puerto Rico and the Virgin Islands. Regional inventory report of the national shoreline study. Atlanta, Georgia.

Proc. Fla. State Hort. Soc. 98:328-329. 1985.

BIOLOGICAL CONTROL OF FRANGIPANI RUST WITH *VERTICILLIUM LECANNI*

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Abstract. **Foliar sprays of *Verticillium lecanii* (Zimm.) Viegas conidia at 100, 1000, and 10,000/ml effectively controlled rust (*Coleosporium domingense* (Burk.) Arth.) and defoliation of frangipani (*Plumeria rubra* L.) in greenhouse and field trials. *V. lecanii* required no environmental changes to enhance parasitism.**

The fungus *Coleosprium domingense* is the cause of leaf rust of frangipani. It is probably the most serious disease of nursery and dooryard grown frangipani (1,10,11). The rust occurs on all known cultivars of frangipani throughout its tropical range (10). It causes severe leaf drop in the spring months and is controlled with foliar fungicides (4). In the spring of 1984 uredial pustules were observed to be covered with a white hyphial colony (5). The fungus was identified as *Verticillium leancii. Verticillium lecanii* is used commercially in Europe for biological control of many different species of insects (3), and is reported to provide effective control of bean rust *Uromyces appendiculatus* (1), carnation rust *Uromyces dianthi* (Pers.) Niessl., leaf rust of wheat *Puccinia recondita* f. sp. *tritici* Rob. ex Desm. (8,9), and stripe rust *Puccinia striiformis West (6).*

This paper describes the biological control effectiveness of V. lecanii on greenhouse and field grown frangipani infected with rust.

Materials and Methods

Two tests were carried out in Apr. 1984, one in the greenhouse on nursery stock and the second on field stock.

The greenhouse frangipani stock were inoculated with *C. domingense* uredia spores collected from mature infected leaves gathered from the field. The uredia spores were washed from the pustules on the leaf surface with distilled water into a 100-ml beaker. The resulting suspension of uredia spores was filtered through several layers of cheesecloth and adjusted to 5.0×10^4 uredia/ml. A DeVilbiss atomizer was used to spray the uredia spore suspension onto the leaves of the plants in the greenhouse. The field stock used in the experiment were naturally infected.

A single-conidium culture of *V. lecanii* originally isolated from a naturally parasitized rust pustule on a frangipani leaf was transferred periodically on potato dextrose agar (PDA) and maintained at 25°C (5). This isolate was employed throughout this study.

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Spore suspensions of *V. lecanii* were prepared by adding sterile distilled water to petri plate cultures and gently washing the spores into a small amount of sterile distilled water. Conidia were then washed twice by centrifugation and resuspended in sterile distilled water and adjusted to 100, 1000 and 10,000 conidia per ml with a hemacytometer.

All inoculations were accomplished by atomizing with a DeVilbiss atomizer, conidial suspensions of the fungus on to the upper and lower leaf surfaces. Immediately prior to inoculation, the greenhouse and field stock plants were watered and the foliage thoroughly wetted with a fine misting nozzle.

Conidial suspensions were sprayed on the plants with a DeVilbiss atomizer on 4, 11, 18, and 25 Apr. Relative humidity readings were made daily in the greenhouse by a Fischer sling psychrometer and in the field by a Campbell Scientific Model 201 Relative Humidity Sensor. Disease was rated by estimating the number of pustules on the fourth fully expanded leaf from the branch tip. The percent defoliation was measured by counting the leaves at the time of the first inoculation and the number of leaves at the termination of the test 4 weeks later.

Four replicates were used for each treatment in the greenhouse and the field test and each plot contained four plants.

Results

Rust caused significant defoliation of plants in both the greenhouse and field. Applications of *V. lecanii* conidia at all three concentrations significantly reduced rust on greenhouse and field plants (Table 1). The 1000 and 10,000 conidia/ml were significantly better than the 100 conidia/ml. The same relationships also existed for the control of leaf drop in both the greenhouse and field experiments (Table 1).

The leaf rust ratings following application of *V. lecanii* conidia at 1000 and 10,000 spores/ml was 0.2 greenhouse and 0.9 field, and 0.3 greenhouse and 0.7 field, respectively. The application of 100 conidia/ml resulted in ratings of 1.4 greenhouse and 2.3 field. The control that received no application other than water, developed a mean disease rating of 4.9 in the greenhouse and 5.0 field respectively. The conidia at 1000 and 10,000/ml reduced leaf drop to 0.0% in the greenhouse and field plants. At 100/ml there was 0.4% at 1.1% leaf drop in the greenhouse and field, respectively whereas the control suffered 50.2% leaf drop in greenhouse and 71.0% in the field. The disease ratings in the field tests tended to be somewhat higher than those in the greenhouse. This may have been related to the higher relative humidity in the field and a somewhat lower

Table 1. Efficacy of *Verticillium lecanii in controlling frangipani rust of Plumeria rubra* in nursery and field plots.

Treatment	Rate conidia	Rust rating[z,y] Greenhouse	Rust rating[z,y] Field	Leaf drop (%)[y] Greenhouse	Leaf drop (%)[y] Field
Control	water	4.9	5.0	50.2	71.0
V. lecanii	100	1.4	2.3	0.4	1.1
V. lecanii	1,000	0.2	0.9	0.0	0.0
V. lecanii	10,000	0.3	0.7	0.0	0.0

[z]Rust ratings: 0 = no pustules to 5 = 99% of leaf surface covered with pustules and leaf drop.
[y]Rust rating values are means of 4 replicates with each treatment having 4 plants. Leaf drop averages are based on 4 replicates with each treatment having 4 plants.

Table 2. Relative humidity for the month of April as recorded in the greenhouse and field.

Date (April 1984)	Greenhouse RH[z](%) Min	Greenhouse RH[z](%) Max	Field RH[y](%) Min	Field RH[y](%) Max
1	27	32	57	97
2	29	37	54	96
3	26	33	68	91
4	25	40	88	94
5	28	34	54	94
6	26	38	44	96
7	29	42	27	99
8	24	35	58	97
9	25	31	73	94
10	26	34	69	94
11	29	30	61	98
12	28	36	80	94
13	27	30	66	96
14	29	33	61	95
15	25	34	65	96
16	28	30	*	*
17	27	41	*	*
18	25	33	*	*
19	29	32	*	*
20	26	34	51	95
21	25	37	68	96
22	27	32	69	93
23	28	30	66	95
24	28	32	55	93
25	29	34	73	93
26	25	33	70	93
27	23	35	61	92
28	28	39	59	93
29	26	34	47	95
30	29	38	58	95

[z]Minimum taken at 8:00 AM and maximum taken at 2:00 PM with a Fisher Sling psychrometer.
[y]Minimum and maximum taken automatically with a Campbell Scientific Model 201 Relative Humidity Sensor.

relative humidity in the greenhouse which would give the rust an advantage (Table 2).

Discussion

Outstanding control of rust and leaf drop was achieved on greenhouse and field established frangipani plants as a result of the application of *V. lecanii* conidia sprays to the rust-infected plants. These results support those of Spencer (8) working on parasitism of carnation rust (*Uromyces dianthi*) by *V. lecanii* and Spencer and Atkey (9) studying the parasitic effects of *V. lecanii* on carnation rust (*U. dianthi*) and leaf rust of wheat (*Puccinia recondita*).

The use of *V. lecanii* as a biological control agent on frangipani rust, that is an annual problem for growers of frangipani, merits considerable interest. Foliar applications of *V. lecanii* conidia may have an advantage over chemicals with respect to environmental pollution. Further studies are necessary to determine if fewer applications would reduce rust infection to the level reported in this study. These data are not be construed as a rust control recommendation until cleared for this purpose by regulatory agencies.

Literature Cited

1. Allen, D. J. 1982. *Verticillium lecanii* on the bean rust fungus, *Uromyces appendiculatus*. Trans. Brit. Mycol. Soc. 79:363-364.
2. Arthur, J. C. 1934. Manual of the rusts in United States and Canada. The Science Press Printing Co., Lancaster, Pa.
3. Ekbom, B. S. 1981. Humidity requirements and storage of the entomopathogenic fungus *Verticillium lecanii* for use in greenhouse. Ann. Entomol. Fennici. 47:61-62.
4. McMillan, R. T., Jr. 1984. Oxycarboxin a new fungicide for control of frangipani rust in nursery and field. Proc. Fla. State Hort. Soc. 97:247-248.
5. McMillan, R. T., Jr. 1985. Parasitism of frangipani rust (*Coleosporium domingense*) by *Verticillium lecanii*. Plant Dis. (in press).
6. Mendgen, K. 1981. Growth of *Verticillium lecanii* in pustules of stripe rust (*Puccinia striiformis*). Phytopatholgische Zeitchrift 102:301-309.
7. Shurtleff, M. C. 1966. How to Control Plant Diseases in Home and Garden. 3rd ed. Iowa State Univ. Press, Ames, Iowa.
8. Spencer, D. M. 1980. Parasitism of carnation rust (*Uromyces dianthi*) by *Verticillium lecanii*. Trans. Brit. Mycol. Soc. 74:191-194.
9. Spencer, D. M. and P. T. Atkey. 1981. Parasitic effect of *Verticillium lecanii* on two rust fungi (*Uromyces dianthi* carnation rust and *Puccinia recondita* brown rust of wheat, biological control of plant diseases). Trans. Brit. Mycol. Soc. 77:535-542.
10. Wellman, F. L. 1972. Tropical American Plant Disease. The Scarecrow Press, Inc., Metuchen, N.J.
11. Westcott, Cynthia. 1971. Plant Disease Handbook. 3rd ed. Van Nostrand Reinhold Company.