Field Control of Coconut Lethal Yellowing with Oxytetracycline Hydrochloride

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ABSTRACT

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Large-scale field testing of oxytetracycline-HCl (OTC) demonstrated that it could exert a definite protective effect on apparently healthy coconut palms in areas of advancing lethal yellowing disease (LY). Rates of spread of LY were decreased three to five times over a course of 12-16 months in field plots in Dade County, Florida, when all coconut palms were preventively injected with 1-3 g OTC at 4-month intervals in comparison to adjacent untreated areas.

Additional key words: antibiotic, mycoplasmalike organism.

With the findings that many yellows-type diseases formerly thought to be caused by viruses were, in actuality, caused by mycoplasmas (1, 2, 20) or associated with mycoplasmalike organisms (MLO) (4, 7) the potentials for disease control with tetracycline antibiotics began to be investigated. Initial reports of disease remission appeared for mulberry dwarf (6) and aster yellows (3) diseases. Subsequently, numerous additional reports of remission of yellows-type diseases in which MLO were associated appeared in the literature. However, in most cases, the beneficial effects of tetracycline treatment were demonstrated to be short-lived, lasting only a few weeks, and prohibitive to apply in a field situation.

In certain instances, long periods of disease remission occurred following treatment with tetracyclines. Nyland and Moller (17) reported that single postharvest injections of oxytetracycline suppressed symptoms of pear decline until the following fall. Suppression of citrus greening in tetracycline-treated budwood lasted as long as 16 months (9) and Schwarz et al. (18) reported up to 24 months remission in greening-diseased citrus trees treated with tetracycline antibiotics. Maramorosch et al. (8) observed remission of the monstrosa syndrome of *Opuntia tuna* for more than 12 months following tetracycline treatment.

Initially, chemotherapy of the lethal yellowing disease (LY) of coconut palm (*Cocos nucifera* L.) in Florida was attempted to provide confirmatory evidence of an MLO etiology of this disease (10, 12). However, the results of these treatments were sufficiently dramatic that their potential for field control of LY was suggested (11). Further investigation demonstrated that complete cessation of symptom development and subsequent stimulation of healthy new growth could last up to 7 months in LY-diseased coconut palms treated with oxytetracycline-HCl (OTC) and that retreatments could maintain a tree in a state of remission (13). Dosage response data indicated that extremely low doses of OTC (100 mg per tree) could have an inhibitory effect on LY although doses greater than 0.5 g per tree gave the greatest ratio of response (90%) in trees treated prior to the development of yellowing symptoms (15). These, and other data from Jamaica (5) on tetracycline treatment of LY were considered of sufficient merit to test the feasibility of using OTC on a large scale for LY control. The results of this program are presented here.

MATERIALS AND METHODS

A cooperative test program involving the University of Florida, the Florida Department of Agriculture and Consumer Services, the City of Miami Beach, the Key Biscayne Chamber of Commerce, and Pfizer Inc. was set up in Dade County, Florida, to determine the effects of wide-scale usage of OTC for LY control. A temporary pesticide registration was granted by the State of Florida for the purposes of this program. Cooperating agencies were assigned certain numbers of trees for treatment and OTC (Pfizer, 'Terramycin® Tree Injection Formula') was distributed to them. All workers involved were trained by state personnel to recognize the stages of symptom development of LY for monitoring purposes.

Sites with high coconut populations in which LY was active were selected for these tests. Sites included parks, golf courses, and uniform street plantings of mature coconut palms. Each site was split into two groups so that matching treated and control areas would be adjacent to one another. All trees in the treated areas were air-pressure injected (14) with either 3 g (apparently healthy trees) or 6 g (diseased trees) of OTC, dissolved in 500 ml of

water except for the Miami Beach group (Bayshore Golf Course) in which each tree received 1 g OTC in 15 ml of water injected with the Mauget® tree injector (J. J. Mauget Corp., Burbank, California 91504). Treatments were applied at 4-month intervals. Trees exhibiting definite foliar yellowing were not treated. All trees were numbered and tagged and records were kept of LY incidence and stage of disease development for each palm in the tests. A total of 2,078 palms were evaluated over a 16-month period with readings made 0, 3, 4, 6, 8, 12, and 16 months from the time of initial treatment. In addition, 1,933 palms on Key Biscayne were treated and disease progress was monitored for an 8-month period. Control trees at three sites inadvertently received OTC treatments at 12 months when OTC became commercially available. These trees were observed for an additional 4 months while subsequent incidence was recorded.

The design chosen allowed calculation of the apparent infection rate of disease, r, (19) in the treated and control areas at each site. The r-value for each site was defined by the slope of the linear regression line determined by plotting the logarithmic transform in [X/(1-X)] against time in months in which X is the proportion of the population that is diseased. Any prophylactic effects of treatment then showed up as depressed r values. This epidemiological approach allowed these preventive evaluations in the absence of any known means of artificial transmission of LY, and in addition allowed comparison of areas differing in initial disease incidence and in total host population.

RESULTS AND DISCUSSION

The use of OTC as a preventive measure slowed the rate of spread of LY in all areas tested, depressing the r-values by a factor of three to five times (Table 1). Figures 1-4 depict disease incidence and rate of spread during the 16-month tenure of this test. The total disease incidence for all treated areas increased from 9% to 27%, an 18% increase over a 16-month period. In the untreated areas, total LY incidence rose from 8% to 83%, a 75% increase over the same time period. The mean r-value for LY in the treated areas was 0.08 per unit per month whereas that in the untreated areas was 0.264 per unit per month. The measured r value for Dade County on the whole was 0.21 per unit per month during the 2 years following the initial establishment of LY (16). Although no control group was available in the 1,933 palms treated in the Key Biscayne group, LY incidence increased from 5.9% to 8.4%, equivalent to an r-value of 0.048 per unit per month during the 8-month tenure of this test. It was interesting that the r-value varied from site to site in these tests, being greatest on those sites that received the highest cultural maintenance practices. Also, the treatment of control trees at 12 months in Peacock Park (Fig. 1), Bayfront Park, and Country Club Prado (Fig. 4) had an immediate depressing effect on subsequent disease spread.

Although LY continued to spread in the treated areas, the r-value was sufficiently depressed that the time required to reach 95% incidence will be lengthened three to five times the 2 years or less calculated for the untreated areas, assuming that the current r-value remains constant in the future (Table 1). In any case, this time base is sufficient to allow underplantings of the resistant 'Malayan Dwarf' coconut to reach sufficient size to replace the 'Jamaican Tall' coconuts lost to LY in Florida. Thus, the transition from susceptible to resistant cultivar may be achieved without interruption of tall palms in the landscape. In addition, these incidence data do not take into account any therapeutic effects of OTC treatment on

TABLE 1. Degree of control of lethal yellowing, a disease associated with mycoplasmalike organisms, offered by preventive injections of oxytetracycline-HCl among 2,078 coconut palms in Dade County, Florida, over a 16-month period

Site	Initial no. of trees	Infected trees: Initial (%)	Infected trees: Final (%)	r per unit per month[a]	Correl.[b] coeff.	No. years to 95% incidence[c]
Doral Country Club						
Treated	301	04	24	.13	.98	4.0
Control	297	04	92	.38	.98	1.2
Peacock Park						
Treated	272	23	34	.05	.94	10.0
Control	80	24	80	.25†	.99	2.0
Bayfront Park						
Treated	341	09	22	.05	.95	10.0
Control	80	04	32	.16†	.97	3.0
Country Club Prado						
Treated	103	17	40	.09	.91	5.5
Control	65	28	97	.31†	.97	1.5
Bayshore Golf Course						
Treated	373	02	06	.08	.87	6.0
Control	166	03	61	.22	.96	2.0

[a] r = slope of linear regression line defined by logits of percent disease incidence over time.

[b] Fit of calculated r to actual incidence data, † indicates r calculated on 12-month base due to treatment of control palms at 12 months.

[c] Calculated time from 5% to 95% incidence using r obtained by linear regression.

palms that do become diseased. Past information has indicated that 50% of such trees may be brought into and maintained in a state of full remission (symptomless) when treated prior to the development of foliar yellowing (15). Such trees must be watched carefully and retreated at 4-month intervals or sooner, if symptom development resumes.

The level of LY control thus achieved, both prophylactic and therapeutic, is considered to be economically viable in Florida where the coconut palm is grown primarily as an ornamental tree. On a plantation crop basis the benefits of treatment would have to be carefully evaluated in light of the costs of application. However, it is possible that a grove of palms immediately threatened by LY could be kept in production for the 4-5 years required for underplantings of 'Malayan Dwarf' coconuts to come into bearing after planting.

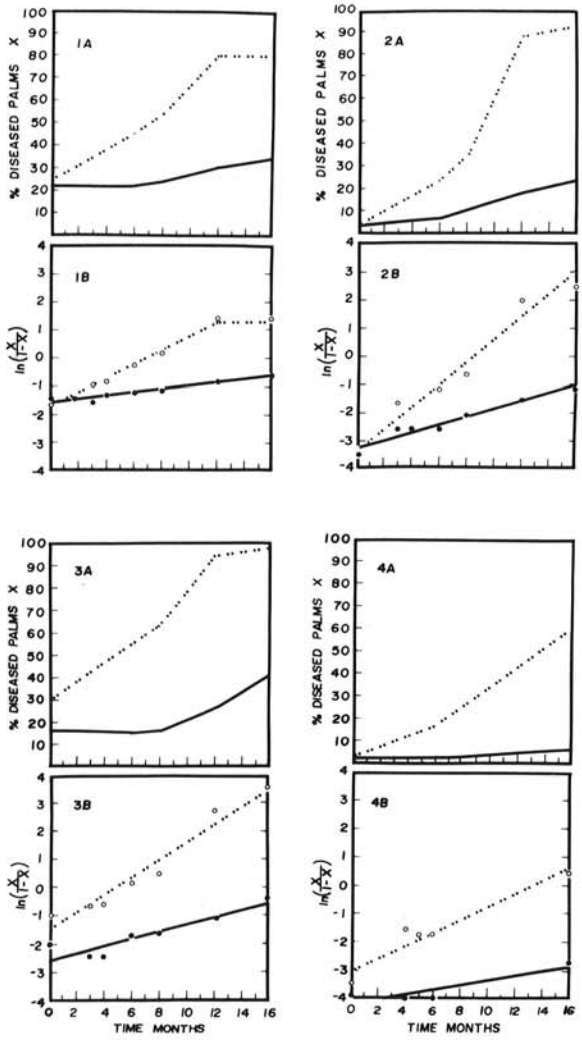

Fig. 1-4. Proportions of coconut palm populations exhibiting symptoms of lethal yellowing (LY) in Dade County, Florida; solid line depicts groups in which all palms were treated with oxytetracycline-HCl, dashed line = untreated groups. A = percentage LY incidence, X, over time. B = logit of X over time. **1)** Peacock Park, Miami; **2)** Doral Country Club, Miami; **3)** Country Club Prado, Coral Gables; **4)** Bayshore Golf Course, Miami Beach.

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