

PETIOLE INJECTION OF COCONUT PALM, A METHOD TO PREVENT PERMANENT TRUNK INJURY DURING ANTIBIOTIC TREATMENT FOR LETHAL YELLOWING¹

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Abstract. Treatment of coconut palms with trunk injections of the antibiotic oxytetracycline-HCl has come under widespread use for control of the lethal yellowing disease in Florida. The principal drawback to the treatment methods

currently in use is that a permanent injury is made to the trunk at the site of injection. An alternative method of injecting the bases of leaf petioles was found to be of definite therapeutic value in diseased palms, even though high overall tissue concentrations of antibiotic were found only in the treated fronds.

Antibiotic treatment of coconut palms (*Cocos nucifera* L) with oxytetracycline-HCl (OTC) has been extensively utilized since 1974 in Florida as a control measure for lethal yellowing (LY), a disease associated with a mycoplasma-like organism. The only treatment method found to produce con-

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sistently acceptable levels of disease control and high foliar levels of OTC in previous tests has been injection of aqueous solutions of the antibiotic directly into the trunk of the tree (1, 5). Foliar sprays and soil drenches had no effect on disease expression and produced little or no detectable OTC in foliage (3). Trunk injections, however, produced an even distribution of antibiotic throughout the foliage within 2-3 days (5); trunk injections were efficient to apply on a large scale basis in terms of labor and expense (3), and were effective in suppressing LY symptom development in diseased coconut palms (4).

The major drawback to the trunk injection method is the drilling of a 3-6 mm diameter hole approximately 75 mm deep into the trunk at the injection site. Since coconut palms produce no secondary trunk growth, these holes remain indefinitely. Sap may bleed from the injection sites resulting in dark stains on the trunk (Fig. 1), and these holes may serve as sites for secondary infections. Bleeding



Fig. 1. Stain produced by bleeding from wound incurred through trunk injection.

may be prevented by plugging the injection holes, but the injury remains nonetheless. This study explored the potential use of petiole injections of OTC to control LY. Such injections do not produce a permanent injury since the injection site is naturally abscised upon the shedding of the injected frond after about one year.

Methods and Results

Two tests were performed to evaluate the petiole injection technique, the first to determine the uptake and distribution of petiole injected OTC, and the second to compare petiole and trunk injections in LY diseased palms.

Oxytetracycline distribution.—Five healthy coconut palms of 1-2 m trunk height were selected for study. One frond in approximately mid-crown in each tree was selected for injection and numbered zero. Fronds above this frond (younger) were numbered positively in phyllotaxic order, spiraling up to the spear (bud) leaf which was number 5 or 6. Fronds subtending the injected frond were numbered negatively in a downward spiral. Treatment consisted of 2 grams of OTC (22.5% soluble powder, Diamond Shamrock Corp., Rahway, New Jersey, 07065, USA) dissolved in 12 ml water and injected with a Mauget™ injector (J. J. Mauget Co., Burbank, California, 91505, USA). Treatment was made as described for trunk injection (2), except the injection was made in a petiole base. It was necessary to hold the feeder tube for the injector unit with a pair of pliers when the injector unit was pushed onto the tube so that the tube was not pushed too deeply into the soft petiole tissue (Fig. 2). High pressure hydraulic injectors could not be used for petiole injections as the tissue split allowing the solution to leak out.

Antibiotic concn in leaf tissue was determined by bioassay using *Bacillus cereus* subsp. *mycoides* (Flügge) Smith as an indicator organism as described previously (5). The minimum threshold for detection of OTC in palm fronds was determined previously to be 0.5 $\mu\text{g/g}$ tissue fresh weight (5). For these tests, three pinnae, one each from the basal, middle, and upper portion of each sampled frond were taken for assay at 3 and 7 days after injection. The distribution of antibiotic into foliage, as depicted in Fig. 3, was essentially restricted to the treated frond in which levels as high as 28 μg OTC per gram tissue fresh weight were detected. Oxytetracycline levels in the untreated fronds were all less than 2 $\mu\text{g/g}$ tissue fresh weight. The highest levels of OTC were found after 7 days in the treated fronds.

Therapeutic efficacy.—The critical measure of petiole injection is, of course, the efficacy achieved in remitting symptom development in LY diseased palms. Twenty-four coconut palms of 2 to 10 m trunk height which were exhibiting primary (pre-yellowing) (4) symptoms of LY were selected and each was treated with 3 g OTC dissolved in 13 cc water. Twelve trees received petiole injections with the Mauget injector as described in the previous section. Six trees received trunk injections with the Mauget injector, and 6 trees received trunk injections with a hydraulic-type injector (Minute Tree™ Injector, Minute Tree Injectors Inc., Miami, Florida).

Subsequent symptom development, recorded monthly for 7 months, is summarized in Table 1. Six of the 12 petiole-treated palms ceased all symptom development after treatment and were producing healthy new growth within 3 months (complete remission), although one of these began renewed symptom production 6 months post-treatment. Four palms exhibited a partial remission after 4 months in that some yellowing symptoms continued to develop, even though new, symptom-free inflorescences were produced. Two trees showed no effect of the treatment as compared to the expected rate of symptom development in untreated palms (4). The trunk injections with the Mauget and hydraulic injectors were not obviously different from the petiole injections in therapeutic response, although the Mauget injections of the trunk appeared to have the best ratio of response in this limited test.

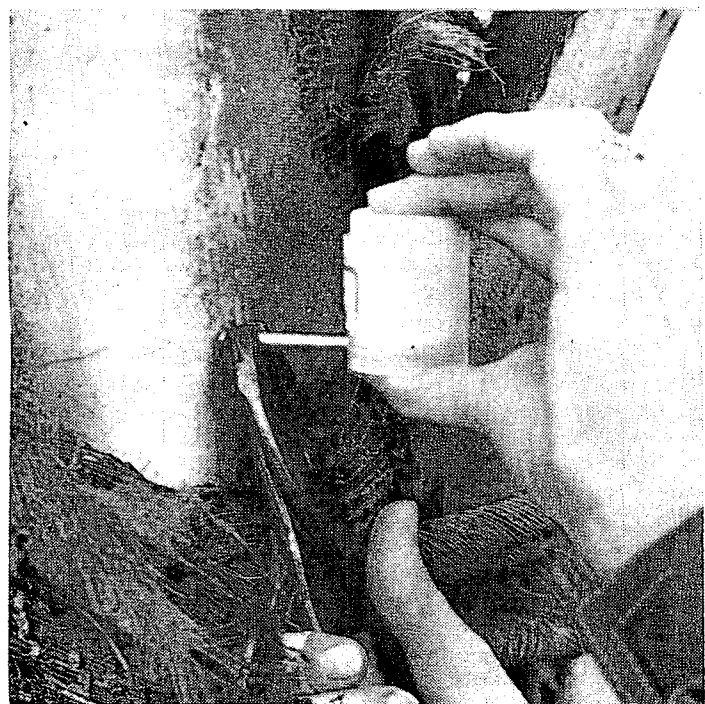
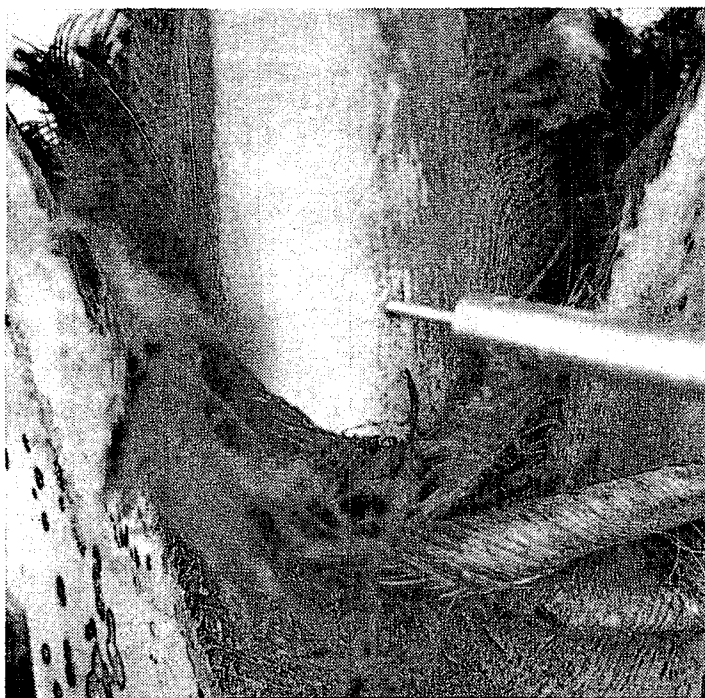


Fig. 2. Petiole injection technique: A-feeder tube inserted to proper depth in drilled hole, B-feeder tube held in place with pliers while injector unit is attached so that tube is not pushed into tissue.

Discussion

Even though the OTC residue determinations presented in Fig. 3 indicate that high overall tissue levels of OTC were obtained in only the single treated frond, petiole injection appeared to be as therapeutically effective as trunk injection. Large scale tests reported previously (4) achieved a rate of complete remission of 50% in trunk-injected diseased trees treated in the pre-yellowing stages of LY, equivalent to the response to petiole injection observed in these tests.

It has been determined that trunk injection will produce uniform foliar levels of OTC (1, 5); therefore it is interest-

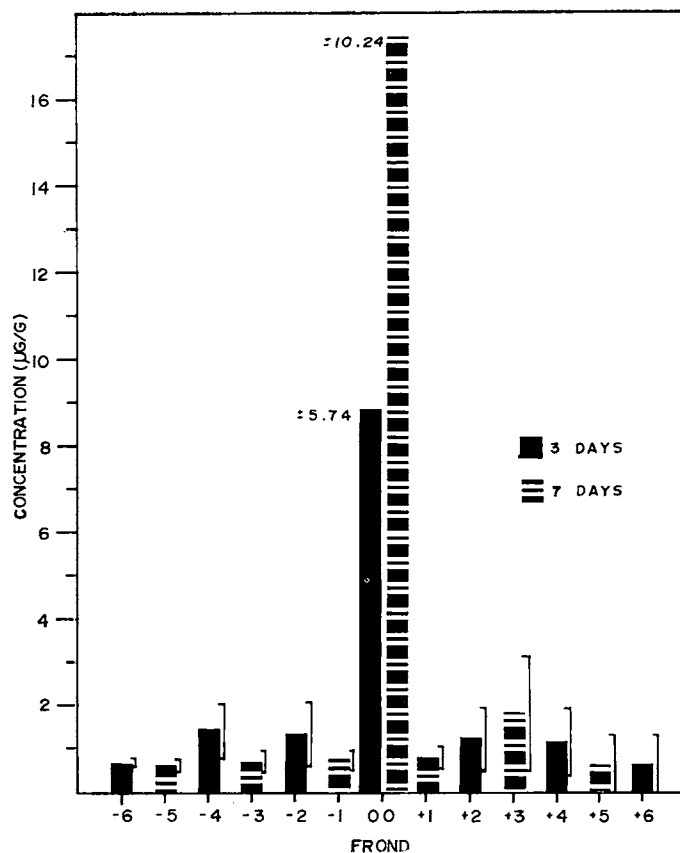


Fig. 3. Foliar concns of oxytetracycline in coconut fronds above (+) and below (-) the single petiole-injected frond of each tree. Mean of 5 treated palms. Brackets represent standard deviations.

ing that petiole injection is equivalent to trunk injection in therapeutic response. The pattern of distribution of OTC after either trunk or petiole injection is indicative of a xylem pathway for initial translocation. To be effective against a phloem delimited mycoplasma-like organism the OTC must get into the phloem. The fact that petiole injection is therapeutically effective is evidence that after OTC moves into the leaf and is distributed throughout the apoplast by way of the transpiration stream, it is then transferred, either actively or passively, into the phloem and exported from the leaf in a systemic manner. This transfer must take place within the tissues of the leaf.

The petiole injection technique was found to be effective therapeutically against lethal yellowing. This technique is significant in that it eliminates the permanent injury associated with trunk injections. Although petiole injection will be difficult to apply to tall trees by individual home-

Table 1. Therapeutic efficacy of three injection methods in lethal yellowing diseased coconut palms, determined 4 and 7 months after treatment. Complete remission denotes a total cessation of symptom development and resumption of healthy new growth. Partial remission denotes resumption of healthy new growth while yellowing symptoms continue to develop in older growth.

Location and Type of Injection	No. Trees	Complete Remission		Partial Remission		No Effect	
		4 mo	7 mo	4 mo	7 mo	4 mo	7 mo
petiole-Mauget	12	6	5	4	5	2	2
trunk-Mauget	6	4	2	1	3	1*	1
trunk-hydraulic	6	2	1	4	4	0	1

*Injector knocked off tree within 24 hours of treatment by falling frond.

owners, many street and park plantings of coconut palms in Florida are trimmed regularly by municipal maintenance crews. The petiole injection could be applied conveniently to such trees at the time of trimming. Treatment should be repeated at 3-4 month intervals to maintain remission. The petiole injection technique might also be investigated as a means of applying exogenous nutrients in cases of mineral deficiencies in coconut and other palms.

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