CONTROL OF CITRUS GREENING DISEASE IN INDIA

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GREENING disease is one of the major causes of decline in citrus orchards in India. The disease is caused by a bacterium-like organism[1] and transmitted by a psyllid vector, *Diaphorina citri*[2]. Attempts have been made to control this malady by the use of certain tetracycline antibiotics[3,4] and Penicillin G[5]. However, these antibiotics have not been found effective in management of the disease in the field. Here we report work in which the effectiveness of a chemical, CPAN No. MJN 1891, under patent in the USA, has been determined in the field and glasshouse.

In the first experiment 12 trees of Malta sweet orange (*Citrus sinensis*) of 10 to 12 years age growing in the orchard of the Indian Agricultural Research Institute, New Delhi, were selected on the basis of symptoms and categorized visually as showing mild, intermediate and/or severe greening symptoms. The experimental trees were indexed for greening before and after eight months of treatment. The trees were also observed for general appearance and health. Suitable control trees were identified and were also indexed against greening on the selected indicator host (Darjeeling orange, *C. reticulata*)[6].

A hole of 25 mm deep and 15 mm in diameter was made in the trunk with a brace and bit. One gram of CPAN No. MJN 1891 (formulation in petroleum jelly) was inserted in the hole with the aid of a clean glass rod. The hole was then sealed with aluminium foil and cellophane tape to make it air-tight and to prevent drying of the compound. All the 12 trees were treated in the way described above. Control trees received no treatment but had identical holes in their trunks filled with petroleum jelly only.

In the second experiment, two-year-old glasshouse-infected seedlings of mosambi (*C. sinensis*) were selected for chemical treatment. Six plants each were sprayed for about two min until runoff with CPAN No. 1891 in concentrations of 500 and 1000 ppm. Three sprays, two weeks apart, were given. Control plants were sprayed with water only.

In the third experiment, eight mosambi plants infected with greening disease were treated by inserting 100 mg of the chemical beneath the bark by giving a clean cut of about 3 cm length in the bark and resealing it. Two plants were used as controls.

The chemical was found to be effective against infection in trees showing mild and intermediate greening symptoms (table 1). The treated trees showed improvement in general appearance and more fruits matured on them. However, severely affected trees did not show significant recovery in respect of either symptoms or fruit bearing. Control, untreated trees showed signs of greater deterioration.

In the second experiment, two of the six plants treated with 1000 ppm CPAN No. MJN 1891 recovered after six months but the chemical caused leaf-tip scorching and unusual curling. Three of the six plants treated with 500 ppm of the chemical showed complete recovery (absence of any disease symptoms) and no phytotoxic effect. Indexing of recovered plants six months after remission of symptoms failed to indicate the presence of pathogen. One plant treated with 500 ppm concentration showed symptoms again after one year.

Table 1 *Results of CPAN No. MJN 1891 treatment of citrus trees for control of greening disease*

Tree no.	No. of fruits matured: Before treatment	No. of fruits matured: After treatment	Back indexing
1*	06	22	–
2**	28	36	+
3*	05	16	–
4**	14	08	+
5**	21	08	+
6*	09	18	–
7**	02	00	+
8*	36	67	–
9*	20	58	–
10*	12	26	–
11 & 12 Died			
Controls			
1**	00	00	+
2**	02	00	+
3**	32	21	+
4**	16	07	+

+, Greening reaction on Darjeeling orange; –, no reaction on Darjeeling orange.
*Flowered normally in following years without visible disease symptoms; fruit setting near normal.
**Trees further deteriorated; flowered heavily but without fruit setting.

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In the third experiment, all the eight plants treated showed complete recovery while the untreated ones showed decline in growth, and absence of development of any new flush of foliage in spring, as was the case in the treated plants. The two untreated plants appear to be on the verge of collapse and death.

Full recovery of six out of eight treated trees originally having mild to moderately severe greening infection indicates high effectiveness of the chemical. This is also reflected in the overall healthy appearance of the treated trees and increase in fruit yield. However, severely affected trees did not show marked recovery or improvement in vigour. During the same period, deterioration of the control trees was more pronounced. The glasshouse experiment shows that spraying of the chemical is less effective and phytotoxicity at higher doses was an additional disadvantage in this mode of application. Reappearance of symptoms in one of the recovered plants indicates that the plant was not completely cured by spray application.

The method of direct insertion of the chemical was found to be the most suitable one as the treated plants recovered fully and reappearance of greening symptoms did not occur. This was further confirmed by indexing.

The effectiveness of the chemical CPAN No. MJN 1891 in controlling greening disease of citrus has been demonstrated. Since the pathogen is restricted to the phloem region, it is essential that chemical application be so designed that the chemical reaches the phloem region or the conducting tissues directly and in the shortest possible time. These studies will be helpful in developing greening-free nucleus planting material and if this material is grown in the vector-free areas already identified[7], it will form a crucial component of the certification programme.

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NATURAL AUTOFLUORESCENCE IN OOSPORES OF *PERONOSCLEROSPORA SORGHI* AND THEIR VIABILITY

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PERONOSCLEROSPORA SORGHI (Weston & Uppal) C. G. Shaw is a major problem for the production of sorghum (*Sorghum bicolor* (L.) Moench) and maize (*Zea mays* L.) in many parts of the world[1,2]. The pathogen produces two types of spores, viz. conidia and oospores. The oospores are mainly responsible for perpetuation of the pathogen through unfavourable seasons[3]. There are several reports on oospore germination in *P. sorghi*[2,4].

According to Williams[2] the subjects of the longevity, viability and germination of oospores of the graminaceous downy mildews are characterized by confusion and contradiction. Time and again the need was emphasized for an improved method for determining oospore viability in graminaceous downy mildews to meet the inadequacies in the previous methods[2,5]. An inverse relationship between natural autofluorescence in fungal spores and their viability was reported by Wu and Warren[6]. The present study was undertaken to determine viability of the oospores of *P. sorghi* using fluorescence microscopy.

Oospores of *P. sorghi* were collected from infected and dried leaves of sorghum by the method of French and Schmitt[7] and stored at room temperature (25 ± 5°C). One-year-old oospores were plated for germination on water agar in petri dishes[4,7]. After 3–4 days, a portion of water agar along with oospores was removed using a cork borer, mounted on a microscope slide and covered with a coverglass, and observed for the presence/absence of autofluorescence. The experiment was repeated thrice and 400 oospores were observed each time.

A Leitz Orthoplan epifluorescence system with a