

**Table 2** Effect of CV, infection on protein content (per cent dry weight) of healthy and diseased bitter gourd leaf, stem and root at different days after inoculation

Days after inoculation	Leaf		Stem		Root	
	Healthy	Diseased	Healthy	Diseased	Healthy	Diseased
10	9.07	10.20	6.67	7.18	6.25	9.04
20	9.81	12.07	7.84	7.90	6.66	9.51
30	12.90	15.30	9.72	10.98	9.60	10.36
40	14.33	16.30	11.51	12.91	10.44	11.87
50	14.63	18.21	13.06	14.61	10.90	13.65
CD value	1.91		1.24		1.99	

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#### INTRODUCTION AND ESTABLISHMENT OF *CHILOCORUS BIJUGUS* MULSANT AND *PHAROSCYMNUS FLEXIBILIS* MULSANT, PREDATORY BEETLES OF SAN JOSE SCALE AT THANEDHAR AREAS IN HIMACHAL PRADESH

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SAN Jose scale, *Quadraspidotus perniciosus* (Comstock) (Hemiptera: Diaspididae) is a notorious pest

virtually occurring throughout the deciduous fruit-growing areas of the world. In India, the pest is believed to have entered for the first time in Kashmir (J&K) during the first decade of 20th century along with some flowering plants, but its seriousness was felt only in 1922<sup>1</sup>. In Himachal Pradesh, it was first reported at Kullu in 1921 and Kotgarh (Shimla) in 1924<sup>1</sup>. At present it is considered to be a serious pest of apple, plum, pear and peach in Jammu & Kashmir, Himachal Pradesh and Utter Pradesh. Because of its waxy covering, development of insecticidal resistance, high cost and hazardous effect of insecticides, chemical control could not gain much importance and necessitated the use of bioagents.

Successful biological control of San Jose scale has been achieved in several countries by introducing and colonizing its parasitoids and predators, a detailed account of which has been given by Tuhan *et al*<sup>2</sup>. To control this pest biologically in Himachal Pradesh, efforts were made by the Central Biological Control Station, Solan (HP) to rear and release its natural enemies. The nucleus cultures of these natural enemies (*Chilocorus bijugus* Mulsant (Coleoptera: Coccinellidae), *Pharoscymnus flexibilis* Mulsant (Coleoptera: Coccinellidae), *Encarsia perniciosi* (Tower) (Hymenoptera: Aphelinidae), *Aphytis* sp. *procha*-group? *proclia* (Walker) (Hymenoptera: Aphelinidae) were obtained from the Central Biological Control Station, Srinagar (J&K) and mass-reared in the laboratory. Before release work, an extensive and intensive surveys were conducted throughout the apple-growing areas of the state, viz., Thanedhar, Kotgarh and Phagu (Shimla district), Bhuntar, Katrain, Jari and Rujak (Kullu district), Rajgarh (Shimla district) and Chail (Solan district) from April to November, 1983 to record the per cent incidence of pest and presence of its natural enemies.

The survey showed that none of the above mentioned bioagents of San Jose scale were present in Thanedhar areas, a progressive apple-growing belt in Himachal Pradesh, although previous reports<sup>3</sup> have shown establishment of *E. perniciosi* and *Aphytis* sp. The cause of extinction of these two parasitoids may be either due to climatic conditions or excessive use of insecticides. In a few selected orchards incidence of San Jose scale varied from 60 to 67% (tree-wise), 30 to 100% (twig-wise) and 40 to 49.2% (axis-wise) during the year 1983. To the best of the knowledge of the authors there is no report of the presence of *C. bijugus* and *P. flexibilis* in Thanedhar areas, although the same have been reported feeding on San Jose scale in Kashmir<sup>1</sup>. After mass multiplication in the laboratory, a total of 60 (1983) and 260 (1984) adults of *C. bijugus*, 265 (1984) adults of *P. flexibilis*, 10,000 (1984) and 3200 (1985) wasps of *E. perniciosi*, 10,000 (1985) and 10,000 (1986) wasps of *A. sp. proclia* group were released against San Jose scale in selected orchards at Thanedhar from April to November. The number released per infested tree varied from 10 to 20 in case of beetles and 1000 to 5000 in case of wasps.

Recoveries made in the following years showed that both the predatory beetles, i.e., *C. bijugus* and *P. flexibilis* are established and coping effectively with San Jose scale population. However, both the parasitoids, i.e., *E. perniciosi* (Tower) and *Aphytis* sp. *proclia* group were not recovered and need further investigation and releases. The number of adult beetles and grubs per tree varied from 100 to 500 during September and October, 1986. Of these two beetles, *P. flexibilis* had low feeding capacity (averagely 15 scale per beetle per day<sup>4</sup>) and cannot cope effectively with rapid increasing population of San Jose scale, while *C. bijugus* has high feeding capacity (averagely 217 scale per beetle per day<sup>1</sup>) and controlled the pest effectively. Many trees heavily infested with San Jose scale were found completely devoid of pest showing only scars of scales. Due to the predacious role of the beetles, the incidence of San Jose scale in selected orchards decreased (10–39.7% tree-wise, 20–26.48% twig-wise and 10–23.81% axis-wise) as compared to previous record. It was also observed that these beetles have automatically spread to a radius of 10 km from the release sites. During winter months (December to March) only adults were seen in the field. Now, adults and grubs are very common in Thanedhar area during summer.

Therefore, it is concluded from the present study that the above predatory beetles are quite promising

as bioagents of San Jose scale in Himachal Pradesh and need protection in the field.

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#### PRESENCE OF RACE 4 OF *FUSARIUM OXYSPORUM* F. SP. *CUBENSE* IN INDIA

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FUSARIAL wilt of banana caused by *Fusarium oxysporum* Schl. f. sp. *cubense* (E. F. Smith) Snyder and Hansen is commonly known as Panama disease<sup>1</sup>. The disease is quite widespread in banana-growing regions of Asia, Africa, Australia, the South Pacific and the Tropical Americas<sup>2</sup>. In southern India the incidence of Panama wilt was found high and in some districts disease incidence<sup>3</sup> ranged from 80 to 90%. There are 4 races of *F. oxysporum* f. sp. *cubense* found on members of musaceae. Races, 1, 2 and 4 cause wilt of bananas and race 3 attacks the wild *Heliconia* species<sup>1,4,5</sup>. Race 1 is distributed world-wide and attacks the common dessert variety of banana belonging to AAA triploids of *Musa acuminata*. The race 2 attacks the cooking variety of banana such as triploids of *M. acuminata* × *M. balbisiana* and is endemic to Central America<sup>6</sup>. The race 4 attacks the cavendish group of banana which is normally resistant to the Panama wilt<sup>7</sup>. This new race was first reported from Taiwan in 1967. Recent reports confirm the occurrence of race 4 of *F. oxysporum* f. sp. *cubense* in Australia, South Africa, Philippines and Canary islands<sup>8,9</sup>. Sivamani and Gnanamanickam recently reported the presence of races 1 and 2 from southern India<sup>10</sup>. From India there is no report on the occurrence of race 4 of the pathogen. This is the first report of the presence of race 4 of *F. oxysporum* f. sp. *cubense* from southern India.