Data Sheets on Quarantine Pests

Quadraspidiotus perniciosus

IDENTITY

Name: *Quadraspidiotus perniciosus* (Comstock)
Synonyms: *Aspidiotus perniciosus* Comstock
Comstockaspis perniciosa (Comstock)
Diaspidiotus perniciosus (Comstock)
Taxonomic position: Insecta: Hemiptera: Homoptera: Diaspididae
Common names: San José scale, California scale (English)
Pou de San José (French)
San José-Schildlaus (German)
Piojo de San José (Spanish)
Bayer computer code: QUADPE
EPPO A2 list: No. 117

HOSTS

The main hosts are apples, peaches, pears, plums and *Rubus*; *Q. perniciosus* has also been reported in Chile on kiwifruits. The scale can attack many other deciduous trees and shrubs, including: *Acacia*, *Acer*, *Amelanchier*, *Chaenomeles*, *Cotoneaster*, *Crataegus*, *Cydonia*, *Euonymus*, *Fagus*, *Juglans*, *Ligustrum*, *Maclura*, *Malus*, *Populus*, *Prunus*, *Ptelea*, *Pyrus*, *Ribes*, *Rosa*, *Salix*, *Sorbus*, *Symphoricarpos*, *Syringa*, *Tilia* and *Ulmus*, making over 150 hosts in total. In the Far East, where the scale is indigenous, it infests *Betula* and wild fruits. These host plants are widely cultivated throughout the EPPO region as fruit crops and ornamentals.

GEOGRAPHICAL DISTRIBUTION

Q. perniciosus is indigenous to Eastern Asia and has spread to many parts of the world.
EPPO region: Widespread in Austria, Hungary, Italy, Spain (including Canary Islands) and Yugoslavia; locally established in Albania, Algeria, Bulgaria, Czech Republic, France, Germany, Greece, Moldova, Morocco, Portugal (including Madeira), Romania, Russia (Southern, Far East), Slovakia, Slovenia, Switzerland, Turkey and Ukraine; has been reported in the field, but is not established, in Belgium, Denmark and Poland, and has been intercepted on imported plums in Norway.
Asia: Afghanistan, Azerbaijan, China (widespread), Georgia, Hong Kong, India (widespread), Iran, Iraq, Japan, Kazakhstan, Korea Democratic People's Republic, Korea Republic, Nepal, Pakistan, Russia (Far East), Tajikistan, Turkey, Uzbekistan.
Africa: Algeria, Morocco, South Africa (unconfirmed), Tunisia, Zaire, Zimbabwe.
North America: Canada (British Columbia, Nova Scotia, Ontario, Quebec), Mexico (unconfirmed), USA (California, Illinois, Maine, Massachusetts, Michigan, New Jersey, New York, Oregon, Tennessee, Washington).
Central America and Caribbean: Cuba.

South America: Argentina, Bolivia, Brazil, Chile, Ecuador, Paraguay, Peru, Uruguay, Venezuela.
Oceania: Australia (widespread), New Zealand.
EU: Present.
Distribution map: See CIE (1986, No. 7).

BIOLOGY

Most individuals of *Q. perniciosus* overwinter in the 1st larval stage, and the remaining few as gravid adult females. All other stages perish in winter, except in areas with very warm climates. The first larval stage is very cold resistant, and about 20% were reported to withstand long periods at -30°C. The threshold temperature for development of 1st instar larvae is around 9-10°C, although development at this temperature is extremely slow. Hibernation is broken in February to March when the larva quickly moults, giving rise to the 2nd instar. At this point, the sexes can be distinguished, since the female scale cover remains round, while male scales take on an elongated shape. The 2nd stage lasts 10-12 days and is terminated by the 2nd moult, giving rise to a prepupal stage in the male. A 3rd moult follows in another 6-10 days, giving the male pupal stage, and a 4th moult 4-5 days later, from which winged males, lacking mouthparts, emerge. At the 2nd moult the females become adult and, as they mature, gradually increase in size until the scale cover reaches about 2 mm in diameter; they remain stationary, feeding.

Adult males, which have limited flight ability, are mostly carried in wind currents and by birds. They mate with the females, which are not parthenogenetic. The female weaves an arched exit of bands of secretion at one edge of the scale, and secretes a soft whitish cushion around her pygidium. Females are viviparous, birth occurring 30-40 days after copulation (end May to beginning June); the mobile larvae emerge within 1-2 min and crawl or are carried by birds, within a further 2 min to 24 h, to infest new host tissue. Females can lay from 50-400 larvae over a period of 6 to 8 weeks. Once a suitable location is found, the crawler fixes itself to the host by deeply implanting its rostrum. This is the most vulnerable stage in the life cycle and mortality rates are high. Once attached, the crawlers secrete a persistent, waxy substance which forms the scale cover. This is white initially, but becomes grey and then black. During the successive moults, the exuvia (cast skins) are incorporated into the scale cover.

There are two complete generations and one partial each year in Switzerland, three to four per year in more southern areas and only one in the more northerly parts of the EPPO region. For the 1st generation larvae, the development temperature sum (>7.3°C) is less than 500 day-degrees C; for the 2nd generation, the temperature sum is 770 day-degrees C. The total life cycle is completed in 60, 42 and 30 days at 20-21°C, 25-26°C and 31-32°C, respectively. At 31-32°C, marked mortality of 1st and 2nd instar larvae occurs while, at 39-40°C, normal larval development ceases. A large proportion of 2nd generation larvae, born at the end of July to beginning of August, enter diapause when at the black scale stage and overwinter in this form. Temperatures below 25°C are reported to induce extended diapause. In general, in the field, high temperatures and low humidity lead to high mortality, while light rainfall and warm weather (25-30°C) favour population increase; heavy rainfall washes very young larvae off the leaves.

For further information, see also Vasseur & Schvester (1957), Gentile & Summers (1958), Mathys & Stahl (1964), Freitas (1966; 1975), Huba (1969).

DETECTION AND IDENTIFICATION

Symptoms

All surface parts of young host plant tissue are infested. Attacks are generally on wood but, in severe infestations, leaves and fruits may also be penetrated. Within 24 h of the larva fixing itself, a characteristic violet-red halo appears around the rostrum. Haloes increase in size as the larvae mature and may coalesce. The red cortical tissue swells with accumulating sap. This red coloration is not specific to *Q. perniciosus*; it has also been reported on *Ligustrum* infested by *Q. ostreaeformis*. Bark often cracks and exudes gum, resulting in a surrounding dark-brown gelatinous area. Heavy infestation causes cessation of growth and loss of yield.

Morphology

Positive identification of *Q. perniciosus* requires microscopic observation, in particular of the female pygidium.

Larva

Depending on stage and sex, is a round to elongated, white to black, fixed scale, or tiny mobile yellow organism with three pairs of legs.

Adult

Female: The female is circular, grey and about 2 mm in diameter. Removing the scale reveals the pyriform insect body which bears characteristic ornamentations on the posterior part (pygidium). These consist of two pairs of lobes (one median and one lateral) and three short, largely spaced (exterior, lateral and median) combs. There are no glands around the vulva.

Male: The adult male only has forewings present, the hind pair being reduced to slender halteres linked to the wing bases by hooklets; mouthparts are absent.

For further information, see also Mathys & Stahl (1964), Boehm (1972), Geoffrion (1976).

MEANS OF MOVEMENT AND DISPERSAL

The 1st instar crawlers are the main dispersal phase but are not normally carried more than a few kilometres by the wind. Although males have some flying ability and can be carried by wind, females are not dispersed in this way, which is principally why it is possible to regulate the distribution of the pest by official measures. International spread is liable to occur through human transport of planting material of host trees and shrubs, or fruits.

PEST SIGNIFICANCE

Economic impact

Since 1873, when *Q. perniciosus* was discovered in California (USA), the numbers of devastated orchards in the USA has not ceased to increase. *Q. perniciosus* continues to be the most important scale insect of fruit and nut trees in California. It damages trees by injecting toxic saliva and, in the absence of control, young apple and pear trees, for example, can be killed within 2-3 years. Fruit quality and marketability are greatly reduced by scale attacks. In the EPPO region at present, the San José scale is of great economic importance in Bulgaria, Hungary, Italy, Moldova, Portugal, Russia, Spain, Turkey and Ukraine. *Q. perniciosus* does not appear to cause more damage in areas where only two generations develop. Its distribution and importance in central and eastern Europe has been updated by Kozár & Konstantinova (1981). In the Far East, where the scale is indigenous and only has one generation annually, it causes little harm.

Studies on pears in Oregon (USA) indicated that an infestation level of 1% infested spurs in late April or 4% in July would result in harvest damage in excess of 2% infested fruit, the latter being about the maximum tolerable economic loss for the scale on pears (Westigard & Calvin, 1977).

Control

Chemical control can be achieved in orchards with applications of mineral oils in winter against the wintering stages and applications of chemicals, such as methidathion, during the growing season. For summer treatments, sex pheromone traps can be used in order to monitor the level of male adults, and therefore to determine the time of application. Biological control with the hymenopteran *Encarsia perniciosi* (Aphelinidae) has also been used in orchards and private gardens.

Phytosanitary risk

Q. perniciosus is listed as an A2 quarantine pest by EPPO (OEPP/EPPO, 1981) and is also of quarantine significance for APPPC.

In more northern zones, the San José scale is able to exist, but is not likely to cause much damage, as its reproductive potential and development are much reduced at low temperatures (Gentile & Summers, 1958). The main risk remains to countries in western Europe, where the species is absent or has a limited distribution at present (e.g. France, Switzerland). There has been some discussion within EPPO as to whether international quarantine measures need to be maintained against *Q. perniciosus*,or whether internal measures would suffice; the conclusion in 1983 was that the species should remain on the quarantine list.

PHYTOSANITARY MEASURES

EPPO recommends (OEPP/EPPO, 1990) that countries may prohibit importation of plants for planting (of host plants) from areas where the pest occurs during specified periods, as for example in summer, when treatment is impossible because of the risk of phytotoxicity. Countries should require that consignments come from a field found free from *Q. perniciosus* during the last two growing seasons and may also require fumigation of the consignment. However, under certain conditions, countries may accept a tolerance for this pest on fruits. The EPPO recommendations also define which species of host plant are considered significant enough to be covered by requirements.

Woody host plants in full dormancy can be fumigated at atmospheric pressure with either hydrogen cyanide, 5 g/m^3 (initial dosage) for 30 min at 4-25°C, or methyl bromide, 50, 35 or 40 g/ m^3 (initial dosages) for 3, 3 or 2.5 h at 10-15, 16-20 or 21-25°C, respectively (OEPP/EPPO, 1982).

Cold storage of apple consignments in standard or controlled-atmosphere storage for at least 4 months resulted in over 90% mortality of the scale insects in the overwintering stage and loss of vigour and complete loss of reproductive capacity in surviving individuals transferred to a temperature of 22°C (Dickler, 1976).

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