

DAMAGE TO APPLE CROPS INFESTED WITH SAN JOSE SCALE, *Quadraspidiotus perniciosus* (Comst.)

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ABSTRACT

The damage caused to apple fruit by San José scale, *Quadraspidiotus perniciosus* (Comst.), consists of red blotches and pitting. In Auckland, study of 5 apple varieties showed no variation in varietal susceptibility to the scale. The life history of San José scale in relation to the development of the fruit is described. Three generations may be present on a single fruit. The second generation is the most damaging. Initially, most red marks are caused by first instar nymphs. Of the total number of scales observed producing red marks on fruit, 62 per cent were sexed forms; and of these 65 per cent were male scales.

INTRODUCTION

San José scale, *Quadraspidiotus perniciosus* (Comst.), is one of the major pests in the apple growing districts of the world. No part of the tree is immune to its attack. Young trees may be killed, while mature trees may have their vigour permanently affected. Even more important is the damage done to crops, which may cause a large percentage of fruit to be discarded at harvest. As all export lines of fruit from New Zealand are required to be perfect, it has become essential to understand the life cycle of the scale in New Zealand (Richards in press) and know when fruit are most susceptible to its attack.

In the Auckland district, an orchard was selected comprising 30 dwarf apple trees. These were divided equally into 5 varieties. Spraying trials were carried out on most of the trees (Harrow 1960), but 15 trees were left unsprayed and used as controls. These consisted of 2 Cox's Orange, 5 Golden Delicious, 2 Granny Smith, 1 Jonathan, and 5 Sturmer. For the whole of the 1959-60 season, a study was made of San José scale damage to fruit.

TYPE OF DAMAGE

When San José scale settles on fruit it may cause extensive pitting and the formation of red blotches. Both pitting and red marks mak

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(Photo: S. A. Rumsey.)

Fig. 1.—Close up of Gravenstein apple showing 2 generations of San José scale present around the stem end. ($\times 6\frac{1}{4}$).

the fruit unmarketable. Red marks may form round the scale within 24 hours of crawlers settling on the fruit and commencing to suck the host tissue, but they may also develop several weeks later. The colouration develops in the tissue beneath the epidermis, and soon becomes apparent through the cuticle. As the scale grows, the red mark enlarges, and, where scales are close together, the marks merge into large blotches or streaks. The most susceptible areas are those round the stalk and calyx (Fig. 1), but the scale may spread to the sides of the fruit (Fig. 2). In

severe cases of infestation, thick incrustations may form on the fruit. Over 100 scales have been found on a single apple.

VARIETAL DIFFERENCES

In Auckland, the total harvest of apples from 75 trees in 1 spray trial, namely 1,329 apples, was examined for evidence of scale infestation. The percentage of infested apples varied from 9 per cent in Golden Delicious to 26 per cent in Jonathan, but because of the small numbers of fruits on some trees and large tree to tree variability within varieties, it was not possible to show any significant differences between varieties.

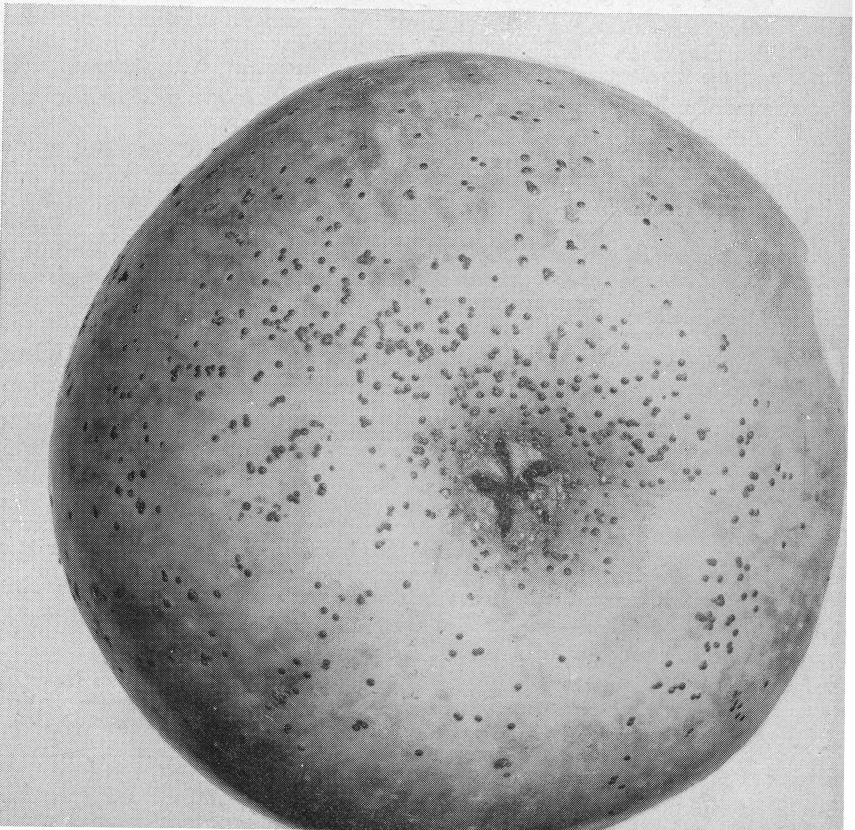
LIFE HISTORY OF SCALE IN RELATION TO FRUIT

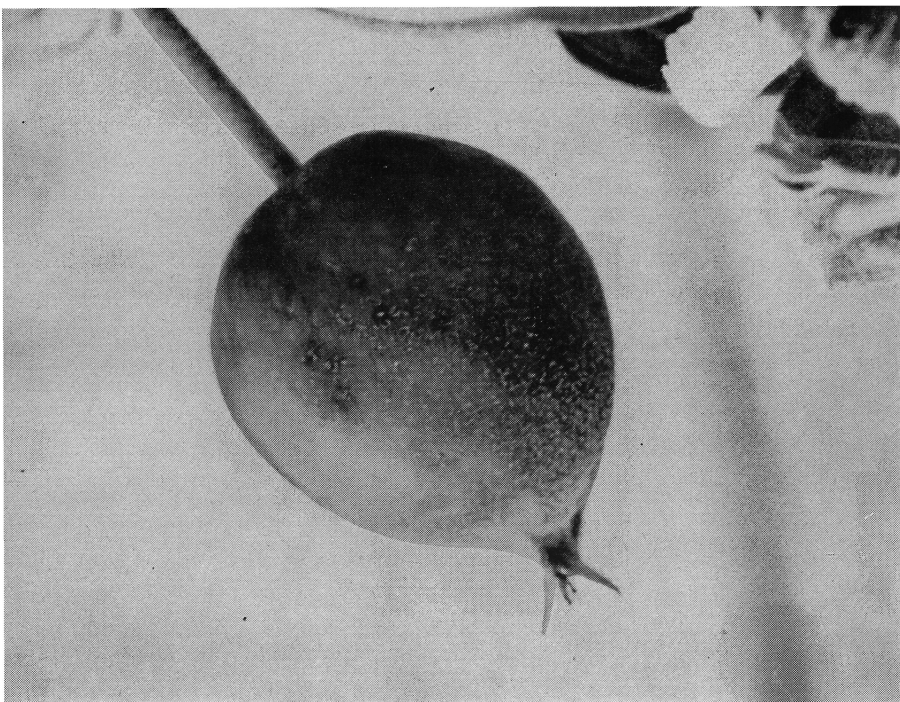
Under New Zealand conditions (Richards in press) 3 to 3½ generations develop each year. Only the mobile crawler stage colonises the fruit.

Crawlers of the first generation are released at petal fall in the latter part of October, and continue to be released to the beginning of December. Crawlers settle on the young fruit causing damage at the

Fig. 2.—San José scale around the calyx and spreading over the whole apple.
($\times 1\frac{1}{3}$).

(Photo: J. W. Endt.)





(Photo: S. A. Rumsey.)

Fig. 3.—San José scale on Sturmer apple late November 1959. ($\times 3\frac{1}{4}$).

earliest stage of development. Fig. 3 taken on 20 November 1959 shows scales that have settled and made red marks on a young apple. Initially, red marks are of a very brilliant intensity, but, as the fruit grows, the marks increase in size and become much paler. In some cases the scale may die and disappear leaving a red blotch to mark where it has been.

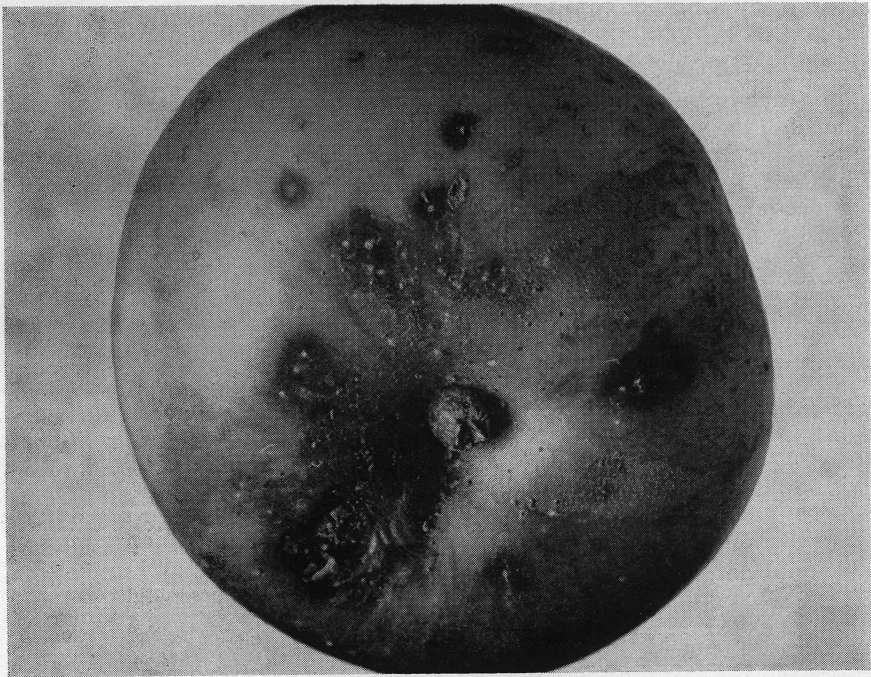
In early February, crawlers of the second generation are released. It is this generation which causes most damage to fruit because there are 2 sources of infection—crawlers from adults on the bark, and crawlers from adults on the fruit. Once again the fruit becomes marked with brilliant red blotches (Figs. 1, 4). Infestation may occur just before harvest and may damage fruit which up to this stage has been unblemished.

Late apple varieties may also be attacked by the third generation crawlers which are released in early April, so that there may be up to 3 generations of scale at the same time on a single apple. As each adult female may produce up to 400 young, a small infestation early in the season is sufficient to produce a very heavy infestation at harvest.

EXAMINATION OF FRUIT AT HARVEST

At harvest 1960, every apple from unsprayed trees was examined under the microscope. From this it was determined that 32 per cent of the scales produced red marks.

San José scale cannot be sexed till the second instar. As the majority of scales examined were in either the first or second instar, the scales



(Photo: S. A. Rumsey.)

Fig. 4.—Two generations of San José scale on apple showing blotching caused by red marks from several scales merging and bright red marks from the second generation. ($\times 1\frac{1}{4}$).

were divided into sexed and unsexed forms. They were also divided into first or second generation (Table 1). The percentage of second generation scales on the fruit at harvest was 90 per cent for scales with red marks, and 95 per cent for those without red marks, the overall average being 94 per cent. This indicates that the second generation of the scale is by far the most important economically.

TABLE 1. *San José scale recorded from unsprayed apples at Owairaka, Auckland*

	Scales	Unsexed	Sexed		Generation	
			Male	Female	1	2
Red mark	433	166	173	94	41	392
No red mark	925	543	198	184	43	882
	1,358	709	371	278	84	1,274

Initially, the majority of red marks are caused by first instar nymphs. At harvest, examination of the scales producing red marks

showed that 62 per cent were sexed forms, while among those not producing red marks 41 per cent were sexed forms, this difference being very highly significant ($P < 0.001$).

Among sexed scales producing red marks 173 were males and 94 females, the sex ratio being 2 : 1 approximately; while of the scales not producing red marks 198 were males and 184 females, the sex ratio being 1:1. The difference between these 2 sex ratios is very highly significant ($P < 0.0001$). These ratios show that male scales cause far more red marks on fruit than female scales.

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