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INSECT *Pests* AND THEIR CONTROL

By C. F. H. JENKINS, M.A., Government Entomologist

The Citrus Red Scale

THE red scale (*Aonidiella aurantii* Masc.) has a wide distribution over the globe, but tends to be a serious pest in those countries with semi-arid climates such as California, South Africa, Palestine and Australia. The native home of the pest is probably China, but it has been known in Australia for over 70 years and it was from this continent that it was introduced into North America.

It has been described by authors as the most serious insect pest of citrus, and in many countries this is undoubtedly true. In Western Australia it is widely established, but probably owing to climatic and other conditions it is not the major pest in this State that it is on the other side of the continent.

DESCRIPTION

The adult female is an almost circular soft-bodied insect, devoid of all powers of locomotion and protected by a hardened waxy test or scale, reddish-brown in colour and about 1/10th in. across. Like all bugs, to which group the scales or coccids belong, this insect has sucking mouth parts, the sucking tube being produced into a remarkable hair-like organ far exceeding in length the whole body of the scale.

The male coccid is rarely seen, and differs greatly from the female. It has a pair of well-developed wings and a tuft of filamentous threads, forming a kind of tail. It passes its early development covered by a waxy scale, but when maturity is reached it pushes out from under its covering and goes forth in search of a mate. The male scales or coverings differ from those of the females in being

rather smaller and oblong instead of circular in shape.

LIFE HISTORY AND HABITS

The red scale, unlike many coccids, does not lay eggs, but gives birth to living young. The young or larvae may remain under the protecting mother scale for a brief period after birth, especially if the weather is cold.

The young scales, on emergence, are only just visible to the naked eye, and look like tiny yellow specks of sulphur. Under a lens they will be seen to have three pairs of functional legs and a pair of feelers or antennae.

As a rule the young or "crawlers" do not migrate very far, but settle down within a few inches of the parent. The active crawling stage may last a few hours or a couple of days, then the mouth parts are inserted into the plant tissue, the antennae and legs are drawn in under the body and the first cottony threads of the covering scale appear. When finally settled down, the red scale remains fixed in position throughout life, with the exception of the winged males.

After imbibing sap for some time the young scale moults its skin and at the same time loses its legs and antennae. It in-

creases considerably in size and adds to the scale covering, then a second moult follows, after which it reaches maturity.

The time required to develop from crawler to adult will vary with the season of the year and the locality. The main

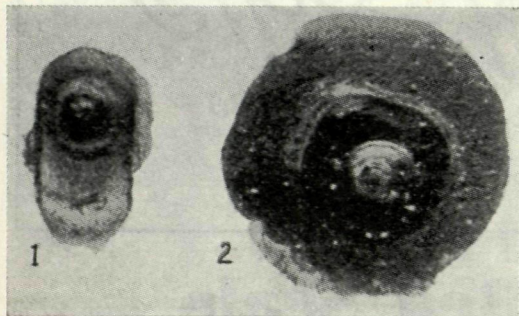


Fig. 1.—(1) Scale of male; (2) Scale of female (enlarged)

breeding season in this State extends from November to May, when several generations may be developed. The exact details are not available for the local breeding rates, but in South Australia it has been shown that it takes about nine weeks in the summer and about 20 weeks in the winter for a newly-hatched female to be ready to give birth to the next generation. After commencing to produce young in the early summer, females may continue to give rise to crawlers for about two months, during which time 150 may be born. This

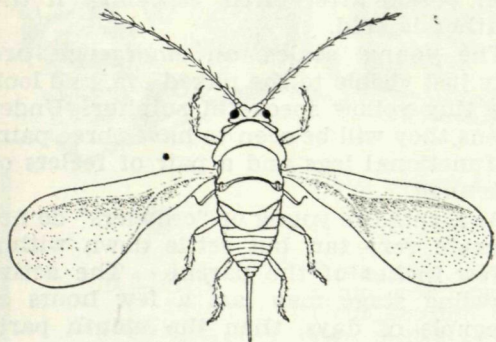


Fig. 2.—Male of red scale

reproduction may continue on fruits even after they have been picked and held in store. Normally, red scale does not reproduce during the winter. Individuals which have settled down just before the onset of the cold weather may go on developing slowly and be ready to breed the following summer, but many will perish.

METHOD OF DISPERSAL

It is clear from what has already been said about the larval scales that their actual movements and activity have little to do with the spread and distribution of the pest. Factors of importance are the

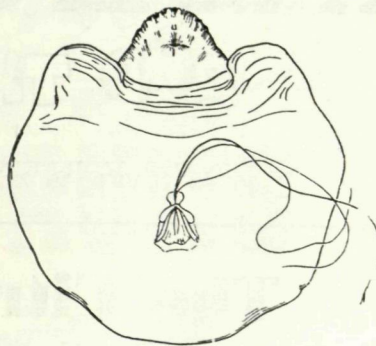


Fig. 3.—Under side of female red scale showing hair-like mouth parts

transport of infested trees and fruits, picking boxes, etc. Wind is probably the chief agent within an orchard, as "crawlers" are known to have been carried 400 ft. by this means. They have also been known to attach themselves to the bodies of birds and insects and thus be carried far afield.

HOST PLANTS

No complete list of host plants in Western Australia is available, but the fact that in South Africa, no less than 200

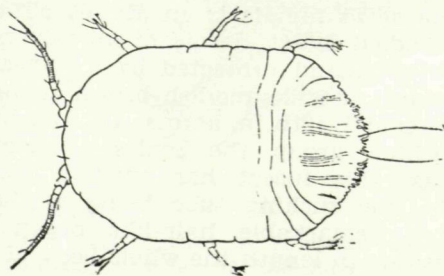


Fig. 4.—Red scale "crawler"

plants have been listed, as carrying the scale, shows that citrus are by no means the only species attacked. Locally, in addition to all types of citrus it has been recorded from figs, mulberries, roses, apples, plums, vines, nectarines, pears, white cedar, castor oil and *Zamia* palms. Although it is of little economic import-

ance on trees other than citrus, these alternative hosts must be considered when sources of infestation or carry-over in an orchard are being investigated.

TYPE OF INJURY

Red scale attacks all parts of the tree, leaves, fruit, twigs and branches. It may become so thick as to form an incrustation of over-lapping scales. It is the only common citrus scale in the State which actually infests the fruit and consequently it may be easily recognised on this account. Another characteristic is the

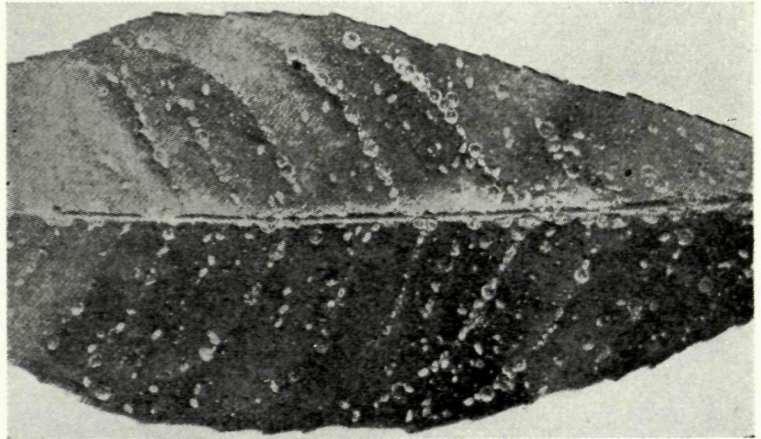
SPRAYS

White Oil.

The most generally used control in this State is White Oil applied in the late summer at a strength of 1 part of oil to 40 parts of water ($2\frac{1}{2}$ gallons per 100 gallons of water or 1 pint to 5 gallons).

Where bad infestations of scale need controlling, two sprays will be found more effective than one. The oil concentration should be halved however (i.e. 1 part to 80 parts of water) and the first spray should be applied in December and the second one about March.

Fig. 5.—Red scale on orange leaf



yellow discoloration which may be seen around the feeding puncture, either on leaves or green fruits. Even when the scale has been rubbed off, this evidence of its presence will persist for some time.

The first indication of the adverse effects of the scale is a yellowing and then a dropping of leaves. In bad infestations, the twigs and young branches may die back, to be followed finally by death of the whole tree. Unlike the black and soft brown scale, the red scale does not secrete honey dew and so the unsightly accumulation of black sooty mould associated with the latter varieties is absent.

CONTROL

Two standard control methods are employed against the red scale, namely, spraying and cyanide fumigation. It has been found, more especially in America, that certain individuals have an extraordinary power of resisting cyanide gas and that a resistant variety of scale is being developed.

Malathion.

Malathion has been found effective against red scale and is recommended at a concentration of 0.1 per cent. to 0.2 per cent. depending on the severity of the infestation ($1\frac{1}{2}$ to $3\frac{1}{4}$ pints of 50 per cent. Malathion concentrate to 100 gallons of water). Investigations overseas and in the Eastern States suggest that Malathion wettable powders may be more effective than Malathion emulsions, but no comparative tests have been done locally. The wettable powder concentrations suggested are 3 lb of 25 per cent. powder to 100 gallons of water.

Malathion—White Oil Combination.

A mixture of White Oil and Malathion will be found useful against both red scale and the citrus white fly. The combination suggested is—

White Oil— $1\frac{1}{4}$ gallons.

Malathion 50 per cent.—1 pint.

Water—100 gallons.

Parathion.

Parathion has been used effectively against red scale but in some instances it has led to an increase in soft brown scale. Malathion has not had this un-

Care of Application.

In applying oil and other sprays it is essential to use high pressure equipment. The insecticides depend upon contact for their efficiency and so must reach the

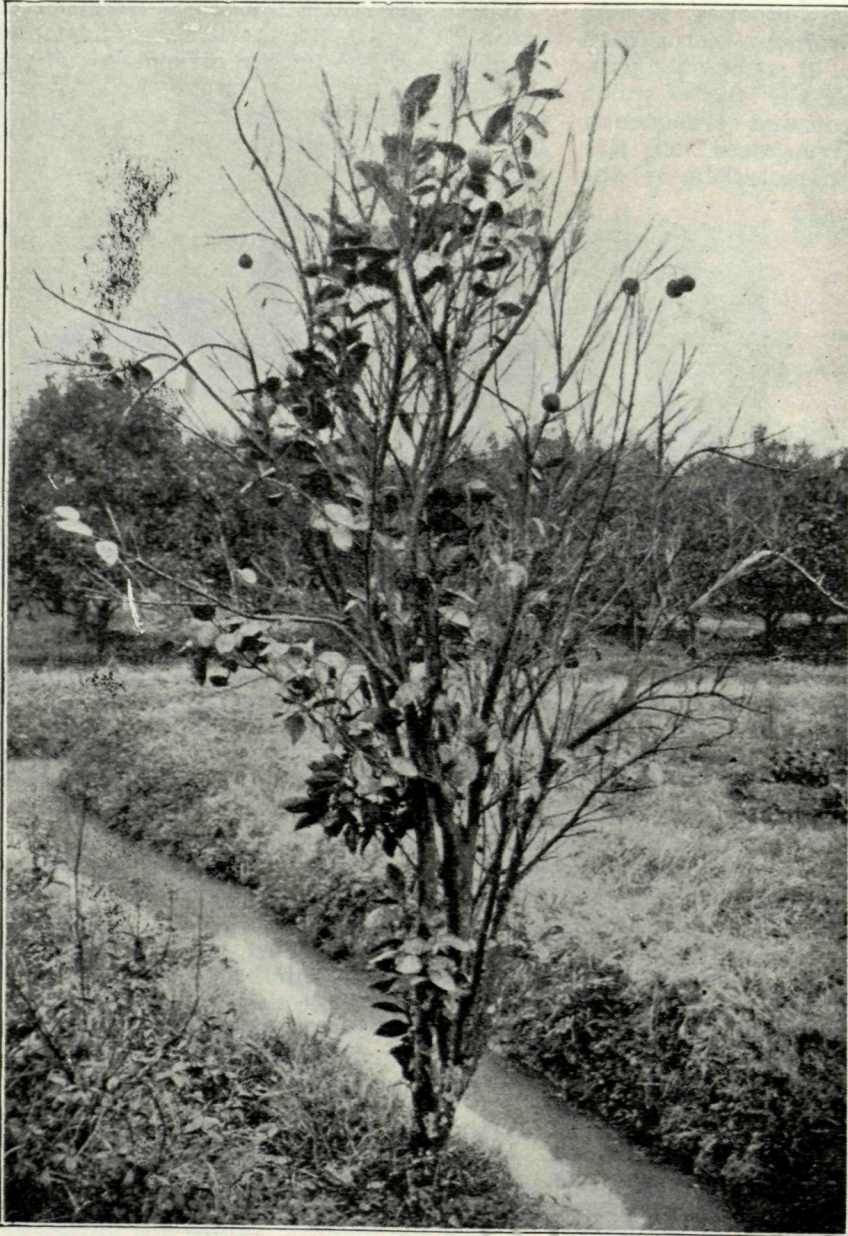


Fig. 6.—An orange tree showing effects of severe scale infestation

desirable effect, and in view of its lower toxicity to humans, Malathion is recommended in preference to Parathion.

centre of the tree and the under surface of the leaves. Spraying should not be done during a heat wave or when trees are

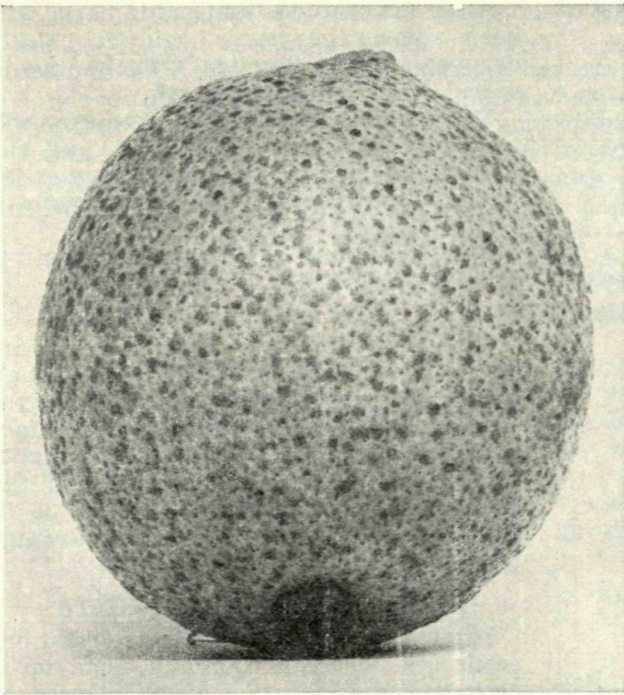


Fig. 7.—Lemon heavily infested with red scale

stressing for want of water, otherwise foliage injury may result.

FUMIGATION

Hydrocyanic acid gas is probably the most universally used agent for scale control, although in Western Australia it is now seldom used. It may be generated either by the old pot method in which the

gas is evolved through the interaction of potassium or sodium cyanide with sulphuric acid and water, or by means of calcium cyanide which is available in both dust and briquette form. Liquid cyanide has also been used satisfactorily in some countries.

The dosage should be carefully measured according to the size of the tree and the

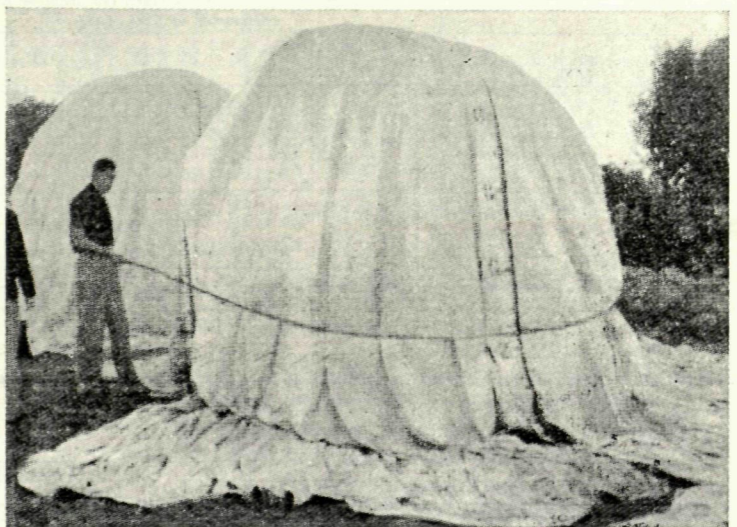


Fig. 8.—Measuring a tent for determining of fumigation dosage

time of the year. Other precautions to observe are as follows:—

- (1) Do not apply fumigation to trees previously treated with copper sprays until a period of six months has elapsed unless the effect on one or two trees has first been tested.
- (2) Do not attempt to fumigate trees carrying free moisture, either in the form of rain or dew. Ill-effects may also follow the use of damp sheets.
- (3) High temperatures and bright light will increase the risk of foliage injury. (For this reason fumigation is usually done at night.)
- (4) Do not fumigate in less than a fortnight after applying an oil spray.

Dosage.—The ingredients are mixed in the following proportions:—

Potassium cyanide—1 oz.

Water—3 fluid oz. (6 tablespoonfuls).

Sulphuric acid—1 fluid oz.

If sodium cyanide is used, the proportion of sulphuric acid should be increased to $1\frac{1}{2}$ oz. and the water reduced to 2 oz.

A glazed earthenware vessel is usually used as a container and the water should be poured in first. The sulphuric acid should then be added very slowly and the pot placed under the fumigation tent near the trunk of the tree.

After the cyanide, wrapped in paper, has been added, the tent should be quickly dropped and the junction with the ground sealed with heaped-up earth.

The amount of fumigant necessary will vary with the size of the tree, and the following tables based upon recommendations of the Queensland Department of Agriculture are included.

The duration of the fumigation is usually 45 minutes

Tents.

The most durable sheets or tents are made from 8 oz. army duck, although lighter material, including medium weight closely woven calico, has been satisfactorily employed. Tents are usually eight-sided and the diameter varies with the size of the trees to be covered. A 36 ft. sheet should be suitable for an average tree 12 ft. in height.

COMBINATION TREATMENTS

Where heavy red scale infestations occur and where a thorough clean up is desired, the application of oil followed by fumigation has been found most successful.

Oil sprays as may be expected are less effective against insects on the wood and interior portion of the trees, whereas the fumigant readily reaches these individuals, while its concentration on the outer parts of the tree may be rather light. It will therefore be seen that spraying and fumigation may be regarded as complementary treatments. The first week in February is

Table 1.—POTASSIUM CYANIDE (45 Minutes Exposure)
Diameter of Tree (feet)

	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
4	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	4
5	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	5
6	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	6
7	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	7
8	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	8
9	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	9
10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	10
11	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	11
12	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	12
13	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	13
14	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	14
15	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	15
16	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	16
17	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	17
18	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	18
19	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	19
20	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	20
21	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	21
22	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	22

Dosage in Ounces

Proportion—Water, 3; Sulphuric Acid, 1; Potassium Cyanide, 1

about the latest that oil sprays should be applied if scale is bad and clean fruit is desired, for although a heavy kill may be obtained from later sprays, the dead scales may fail to drop before the fruit is harvested. If a following fumigation is contemplated, it has been shown in South Australia, that this may be given a month

tive parasites and predators of the red scale. One giving early promise was a tiny yellow wasp *Aphytis chrysomphali* (Mercet.), collected in China and introduced in Western Australia in 1905. It is widely established locally and in some districts plays a part in keeping the scale population within reasonable bounds.

Table 2.—CYANOGAS DUST (45 Minutes Exposure)
Diameter of Tree (feet)

	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Height of tree (feet).	4	1	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
	5	1	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5
	6	1	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6
	7	1	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7
	8	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8
	9	...	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9
	10	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10
	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11
	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12
	13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13
	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14
	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15
	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	16
	17	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17
	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18
	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	19
	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20
	21	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	21
	22	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	22
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	

Dosage in Ounces.

Table 3.—CALCID BRIQUETTES (40 Minutes Exposure)
Diameter of Tree (feet)

	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
Height of tree (feet).	4	1	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4
	5	1	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5
	6	1	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6
	7	1	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	7
	8	...	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	8
	9	...	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	9
	10	...	...	...	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	10
	11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11
	12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12
	13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13
	14	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	14
	15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15
	16	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	16
	17	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17
	18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18
	19	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	19
	20	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	20
	21	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	21
	22	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	22
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	

Dosage in Number of Briquettes

or two months later with equally satisfactory results.

BIOLOGICAL CONTROL

Exhaustive efforts have been made in many parts of the world to discover effec-

In February 1943, a further wasp parasite *Comperiella bifasciata* (How.), was introduced through the co-operation of the C.S.I.R.O. and liberations were made at Harvey, Guildford, Parkerville and Gosnells. The local status of this parasite however, has not been assessed.



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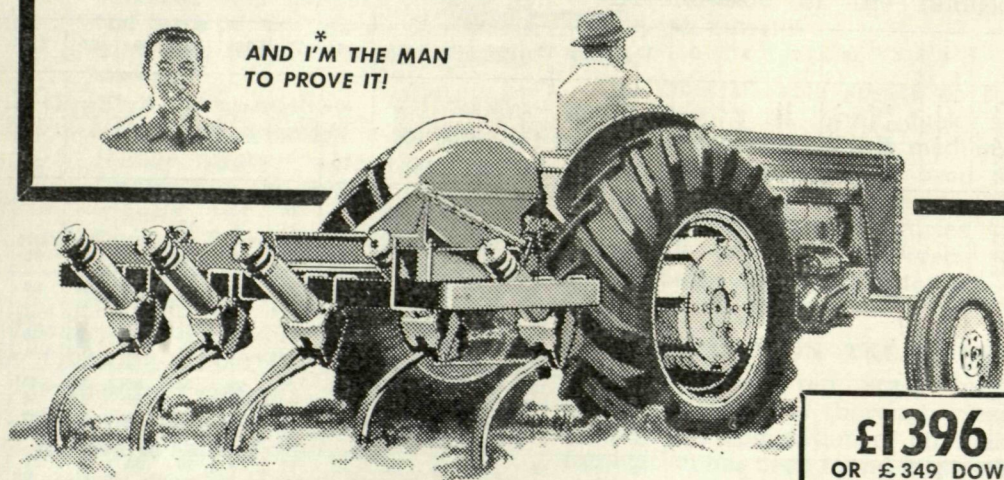
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