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THE SEASONAL HISTORY AND CONTROL OF CEROPLASTES RUBENS MASKELL ON CITRUS IN SOUTH-EAST QUEENSLAND

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SUMMARY

A seasonal history study was made of pink wax scale *Ceroplastes rubens* Maskell in south-eastern Queensland. Two generations were found to occur annually with oviposition occurring from mid September to early December and mid February to early May. Crawlers emerged from mid October to mid December and early March to late June.

Three spray trials were conducted in conjunction with this study to evaluate insecticides alternative to soda ash and to review the timing of spray application.

A single spray in late spring-early summer was considered the most satisfactory.

Methidathion 0·075% or 0·05% plus white oil gave the highest level of control. Satisfactory control was also given by azinphos methyl 0·075% or 0·05% plus white oil, soda ash plus white oil with and without the addition of soap and sodium metasilicate plus white oil.

I. INTRODUCTION

Pink wax scale (*Ceroplastes rubens* Maskell) is an important scale pest of citrus in Queensland. Its copious production of honey dew results in heavy sooty mould deposits over leaves and fruit. It is most common at Howard, but can be troublesome in all coastal and sub-coastal commercial citrus growing areas from Kuranda to the Lockyer Valley and occurs also in the central Burnett (Smith, 1974). Its status as a pest has not changed greatly from 1934 when it was regarded as a dominant citrus scale pest in Queensland (Summerville, 1934). The scale has a wide host range (Brimblecombe, 1956). All varieties of citrus are hosts, and mandarins, particularly the variety Emperor, are the most favoured.

As Blumberg (1934) and Smith (1974) describe, the adult female oviposits 600 to 700 eggs in a cavity beneath the body of the scale. The first instar nymphs or crawlers hatch after 3 to 4 weeks, emerge from underneath the parent scale and settle permanently on twigs and leaves.

Three weeks after settling, when the scale is approximately 0·7 mm long, the first moult occurs. The second moult occurs 6 to 8 weeks after settling when the scale is approximately 1·0 mm long. The third moult occurs 10 to 12 weeks after settling. The adult increases in size from 1·5 mm to 3·5 mm reaching maturity 4 months after settling during summer and 6 months after settling during winter.

In the past, the control method for *C. rubens* has been to spray during March with a solution, in 100 litres of water, of 1·2 to 1·4 kg of washing soda or 0·5 kg of soda ash both in combination with 0·8 kg of soap and 1·25 litres of white oil (Manefield, 1956).

The use of soda ash, however, can cause leaf drop and can reduce fruit size on trees, particularly if applied during periods of water stress or when temperatures exceed 37·8°C. (Smith, unpublished report, Queensland Department of Primary Industries, 1969). Accordingly, trials were conducted to find satisfactory alternative materials and a seasonal history study was made to assist in determining the most efficacious timing of control measures.

II. SEASONAL HISTORY OBSERVATIONS

Methods

Fortnightly observations were made during 1970–71 at two localities: Palmwoods on a block of Washington Navel oranges and Beerwah on a block of Hickson mandarins.

The usual procedure was to collect 100 leaves consisting of four samples of five leaves from five trees at each locality on alternate weeks. The leaves were examined in the laboratory and the scales were allocated to four groups by relating age and instar to size. Periodic microscopic examination was made, determining the instar of scales of a particular size. In the field, foliage carrying newly-settled scales was tagged and scales periodically examined, relating size to age. The four groups were: scales up to 4 weeks old (approximately 0·4 to 0·7 mm long) representing mainly first and early second instars, scales 5 to 8 weeks old (approximately 0·8 to 1·2 mm long) representing second and early third instars, scales 9 to 15 weeks old (approximately 1·3 to 1·9 mm long) representing late third instar and the early adult stage and scales over 16 weeks old (approximately 2·0 to 3·5 mm long) representing mature adults. The percentage of the mature adults with eggs and/or crawlers was recorded. The average sample size was 1200 scales.

Results

The results of the counts at the two localities were combined and are shown in figure I.

Discussion

Two well-defined generations of *C. rubens* were found to occur annually in southern Queensland. Oviposition commenced in mid September and was completed by early December, a period of approximately 3 months. Individuals maturing from the autumn generation commenced oviposition in mid February and this was completed by early May. Spring crawlers first appeared in mid October and ceased emerging by mid December. Crawlers were present in the autumn from early March until late June.

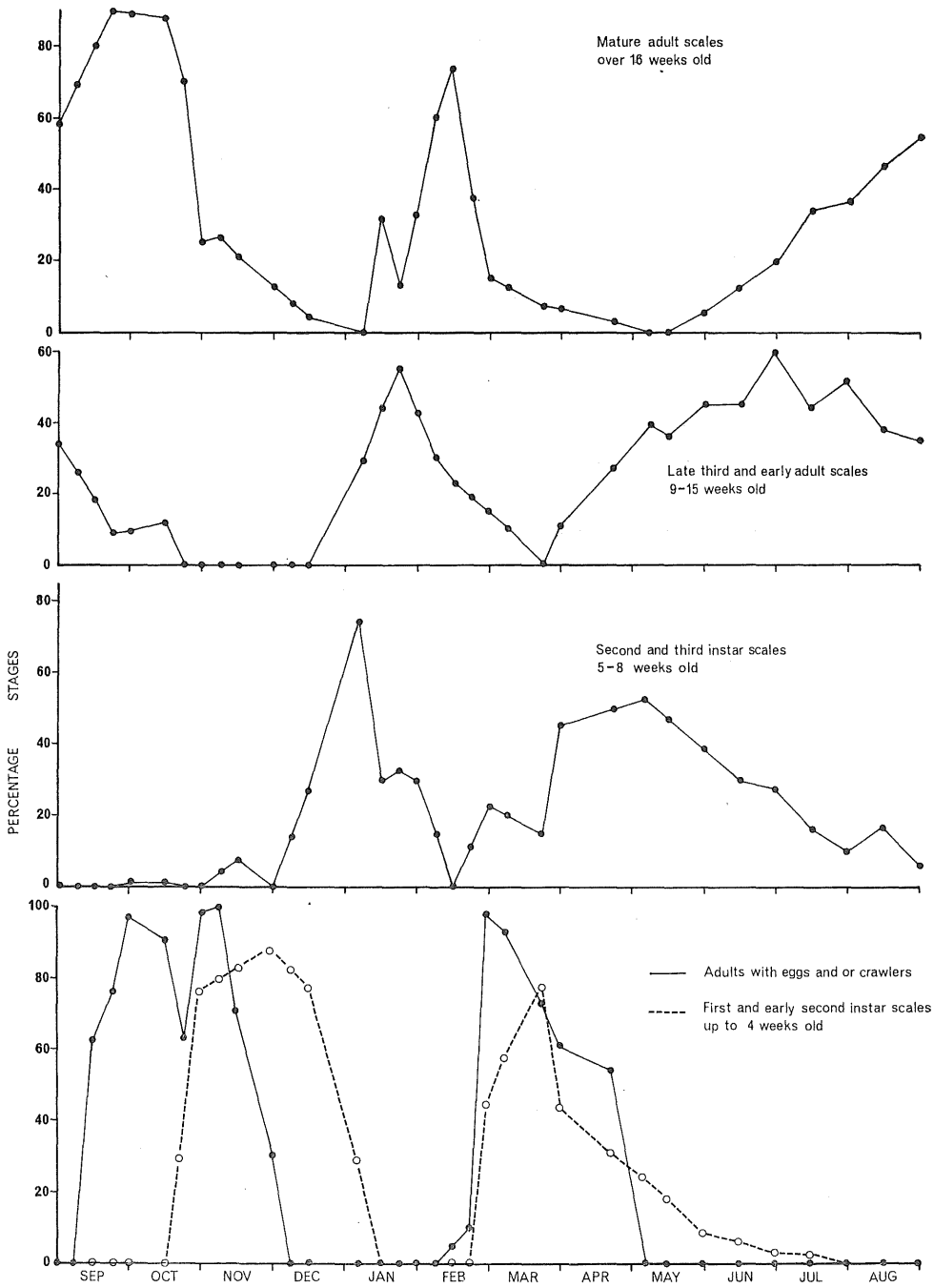

Figure 1.—Seasonal history of Ceroplastes rubens *Maskell.*

Hot dry conditions during November–December caused a high death rate among first and second instar scales. Cold had less effect, as by the beginning of winter few early instar scales remained.

III. SCALICIDE TRIALS

Materials

azinphos methyl—A wettable powder containing 50% w/w active constituent (a.c.)

carbaryl—A wettable powder containing 80% w/w a.c.

maldison—A wettable powder containing 25% w/w a.c.

methidathion—An emulsifiable concentrate containing 40% w/w a.c.

promecarb—A wettable powder containing 50% w/w a.c.

soda ash—Anhydrous sodium carbonate

sodium metasilicate—A formulation containing 29% soda as sodium metasilicate pentahydrate

white oil—A mineral oil containing 80% w/w refined oils.

Methods

Trial layouts were in randomized blocks (four replications in trial 1; and three replications in trials 2 and 3) of single tree plots. Sprays were applied using a hand-held lance and a pressure of 1 000 to 1 400 kPa. Trees were given complete coverage using 14 to 23 litres of spray per tree depending on size. Wetting agent (Agral 60 (R)) 12 ml per 100 litres was used where oil was omitted. Treatments in trial 1 were applied on 4 April 1970, while autumn crawler emergence was incomplete. Treatments in trial 2 were applied on 15 May 1970 when the bulk of the autumn crawler emergence was completed. At this time, the population included scales 9 to 15 weeks old (see figure 1). Treatments in trial 3 were applied on 10 December 1970 at the end of the spring crawler emergence. Single spray applications were made in each of the three trials.

Trial 1 (see table 1) was conducted on young Washington Navel oranges at Palmwoods. A pre-treatment assessment was made at which living adult scales were recorded from 20 random leaves per tree. Scales up to 4 weeks old and scales 5 to 8 weeks old on these leaves were also assessed using a rating system. The rating system was: zero, 0 scales; one, 1 or 2 scales; two, 3 to 10 scales; three, 11 to 50 scales; four, more than 50 scales. A post-treatment assessment was made 3 weeks after application of treatments at which the percentage of dead scales up to 12 weeks old on 20 leaves was determined.

Trial 2 (see table 2) was conducted on Hickson mandarins at Beerwah. In the pre-treatment assessment, all living scales were counted on 20 random leaves per tree. A post-treatment assessment was made 3 weeks after treatment at which the percentage of dead scales in three groups was determined: scales up to 4 weeks old, scales 5 to eight weeks old, and scales 9 to 15 weeks old on 20 leaves per tree. A second assessment was made of all living scales on 20 randomly selected leaves per tree 10 weeks after spraying.

TABLE 1

TRIAL 1—SCALE POPULATIONS AND CONTROL GIVEN BY NINE INSECTICIDES ON WASHINGTON NAVEL ORANGES

Treatment	At Pre-treatment (1 Apr 70)				% Mortality of Scales up to 12 Weeks Old At 3 Weeks Post-treatment (24 Apr 70)	
	No. of Live Adult Scales per 20 Leaf Samples		Live Scales up to 4 Weeks Old	Live Scales 5 to 8 Weeks Old		
	Trans. Means*	Equiv. Means	Means	Means	Trans. Means†	Equiv. Means
soda ash 0·5% w/v + soap 0·8% w/v + white oil 1 : 100	1·041	9·98	21·00	35·25	1·270	91·24
white oil 1 : 100	1·342	20·97	26·25	41·75	1·109	80·11
white oil 1 : 60	1·434	26·18	23·00	39·25	1·416	97·62
carbaryl 0·075% + white oil 1 : 100	1·364	22·12	14·50	40·00	1·357	95·51
carbaryl 0·075%	1·432	26·04	15·00	42·25	1·109	80·16
promecarb 0·05% + white oil 1 : 100	1·367	22·29	23·75	43·50	1·209	87·48
promecarb 0·075% ..	1·209	15·19	30·75	45·75	0·969	67·99
methidathion 0·075% ..	1·216	15·43	14·75	38·50	1·433	98·11
azinphos-methyl 0·075% ..	1·196	14·71	30·00	38·75	1·251	90·10
no treatment	1·326	20·20	11·75	37·00	0·480	21·29
Necessary differences for significance 5%	0·436		15·47	8·25	0·260	
Necessary differences for significance 1%	0·589		20·88	11·13	0·351	

* Log (1 + x) transformation.

† Inverse sine transformation.

TABLE 3

TRIAL 3—SCALE POPULATIONS AND CONTROL GIVEN BY SIX INSECTICIDES ON HICKSON MANDARINS

Treatment	At Pre-treatment (9 Dec 70) No. of Live Scales per 40 Leaf Sample		At Post-treatment (12 Feb 71) No. of Live Scales per 40 Leaf Sample		At Post-treatment (9 Apr 71) No. of Live Scales per 60 Leaf Sample	
	*Trans. mean	Equiv. mean	*Trans. mean	Equiv. mean	*Trans. mean	Equiv. mean
soda ash 0·5% w/v + white oil 1 : 100 ..	2·6805	478·22	0·5017	2·17	1·5838	37·35
sodium metasilicate 1·5 % w/v + white oil 1 : 100	2·6311	426·62	0·7934	5·21	1·9095	80·18
carbaryl 0·05% + white oil 1 : 100	2·6532	449·02	1·4362	26·31	2·1197	130·73
promecarb 0·05% white oil 1 : 100	2·7163	519·38	1·7569	56·14	2·2256	167·11
azinphos methyl 0·05% + white oil 1 : 100 ..	2·6857	483·95	1·2632	17·33	1·5216	32·24
methidathion 0·05% + white oil 1 : 100 ..	2·7501	561·42	0·4337	1·71	1·5300	32·88
no treatment	2·7333	540·15	2·5916	389·44	3·0005	1 000·22
Necessary differences for significance 5%	0·1803		0·6542		0·8507	
Necessary differences for significance 1%	0·2528		0·9172		1·1926	

* Transformation Log (1 + x).

TABLE 2

TRIAL 2—SCALE POPULATIONS AND CONTROL GIVEN BY TEN INSECTICIDES OF SCALES OF DIFFERENT AGES ON HICKSON MANDARINS

Treatment	At Pre-treatment (14 May 70) No. of Live Scales per 20 Leaf Sample		At 3 Weeks Post-treatment (3 Jun 70) % Mortality					At 10 weeks Post-treatment (21 Jul 70) No. of Live Scales per 20 Leaf Sample	
			of Scales 0 to 4 Weeks Old	of Scales 5 to 8 Weeks Old		of Scales 9 to 15 Weeks Old			
	Trans. Means*	Equiv. means	Means	Trans. means†	Equiv. Means	Trans. means†	Equiv. Means	Trans. Means*	Equiv. Means
soda ash 0·5% w/v + white oil 1 : 100 ..	2·176	149·03	100·00	1·425	97·88	1·167	84·56	0·360	1·29
white oil 1 : 100	2·348	221·92	98·06	1·015	72·20	0·599	31·77	1·376	22·78
maldison 0·1%	2·361	228·38	93·60	0·877	59·11	0·671	38·62	1·592	38·08
carbaryl 0·075%	2·152	140·99	97·94	1·005	71·30	0·725	43·94	1·725	52·07
carbaryl 0·075% + white oil 1 : 100 ..	2·255	178·77	100·00	1·276	91·57	0·959	67·01	1·148	13·05
promecarb 0·075%	2·211	161·38	99·18	0·971	68·13	0·662	37·75	1·687	47·69
promecarb 0·05% + white oil 1 : 100 ..	2·280	189·42	97·53	1·169	84·72	0·906	61·94	1·332	20·46
methidathion 0·075%	2·334	214·91	100·00	1·398	97·03	1·202	87·03	0·0	0·0
azinphos methyl 0·075%	2·450	280·73	98·04	1·290	92·31	0·987	69·61	0·766	4·83
white oil 1 : 60	2·402	251·25	97·73	1·183	85·73	0·967	67·76	0·857	6·19
no treatment	2·394	246·48	4·31	0·396	14·85	0·312	9·41	2·109	127·50
Necessary differences for significance { 5%	0·181		N.S.‡	0·217		0·185		0·533	
1%	0·246			0·296		0·252		0·727	

* Log (1 + x) transformation.

† Inverse sine transformation.

‡ No significant differences between applied treatments. All applied treatments significantly different from control.

N.S. not analysed because of several 100% values.

Trial 3 (see table 3) was conducted on Hickson mandarins at Beerwah. In the pre-treatment assessment, all living scales were counted on 40 randomly selected leaves per tree. Further similar assessments were made 9 weeks and 16 weeks after spraying in which all living scales respectively on 40 and 60 randomly selected leaves per tree were recorded.

Results

Results are given in tables 1 to 3.

Discussion

MATERIALS. Methidathion 0·075% or 0·05% plus white oil gave the highest level of control in the three trials. Satisfactory control was also given by azinphos methyl 0·075% or 0·05% plus white oil, soda ash plus white oil with and without the addition of soap and sodium metasilicate plus white oil. Carbaryl plus white oil, promecarb plus white oil and white oil 1:60 gave a lower level of control and were less consistent. Carbaryl and promecarb used without white oil, white oil 1:100 and maldison were unsatisfactory being only efficacious against scales younger than 4 weeks. In trial 2, soda ash plus white oil and white oil 1:60 caused more dead scales and sooty mould to peel off the leaves than other treatments; this may have lowered mortality assessments for these two treatments.

Scale mortality dropped quickly with most materials with increasing age of scales at time of spraying. Mean percentage mortality for carbaryl, for example, in trial 2 decreased from 97·94% for scales up to 4 weeks old to 71·30% for scales 5 to 8 weeks old to 43·94% for scales 9 to 15 weeks old. Variation in mortality for scales of different ages was much less with methidathion and soda ash (table 2).

No phytotoxicity resulting from the treatments was evident in any of the trials.

TIMING OF SPRAY APPLICATION. Most satisfactory control will be obtained by spraying when scales are not older than 8 weeks and when the crawler emergence for the generation is complete. The crawler emergence of the spring generation extends over a shorter period than that of the autumn generation (figure 1). It is therefore preferable to control the scale with a single spray at the end of the spring generation (late November to early December). Control of the scale at this time prevents the accumulation of sooty mould on the fruit during autumn and coincides with control measures recommended for other scales on citrus (Anon. 1975). In addition, oil sprays applied after February, particularly on early varieties and mandarins, can cause colour retardation and reduction in fruit size. A spray in early summer has the advantage of permitting the addition of oil. If control becomes necessary in the autumn, a spray of methidathion 0·075% in late April would be satisfactory.

IV. CONCLUSION

Methidathion used at 0·075% or 0·05% + 1:100 white oil was the most satisfactory alternative material to soda ash for the control of *C. rubens*. An application time during late spring into early summer was found to be preferable to one during the mid to late autumn.

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