QUEENSLAND DEPARTMENT OF PRIMARY INDUSTRIES

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# CONTROL OF AONIDIELLA AURANTII (MASKELL) AND CHRYSOMPHALUS FICUS ASHMEAD ON CITRUS IN SOUTH-EASTERN QUEENSLAND

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**SUMMARY**

**Eight organic insecticides and six brands of mineral oil were tested against two major scale insect pests of citrus, *Aonidiella aurantii* (Maskell) and *Chrysomphalus ficus* Ashmead. Effective control of both scales was given consistently by methidathion and omethoate and (on the one occasion when used) by 2·5% white oil. Effective control of *A. aurantii* was also given by promecarb plus white oil (used on two occasions) and azinphos methyl plus white oil (used on one occasion). Dimethoate and parathion gave a lower level of control of *A. aurantii*. Low strength oil sprays 1% and 1·25% were sufficiently effective against both scales to warrant further testing in an integrated control programme.**

## I. INTRODUCTION

Red scale (*Aonidiella aurantii* (Maskell)) and circular black scale (*Chrysomphalus ficus* Ashmead) are two important scale pests of citrus throughout Queensland. Before 1970, the control method in inland areas was to spray with 1·67% white oil twice in early December, and with 2·5% white oil once in late January if necessary. On late varieties, the third spray could be applied during March–April. On Glen Retreat mandarins, which are prone to injury with oil, single sprays in early December and late January with 1·25% white oil plus parathion 0·015% were used (Manefield 1957).

While oils were preferred to available organic insecticides because of lower toxicity to natural enemies, a heavy oil schedule caused irregular ripening on early varieties picked green–mature for degreening (Smith 1964). Also, oils applied after February caused colour retardation and reduction in fruit size in all citrus varieties. The current work was conducted to screen some of the newer organic insecticides, and also various oil formulations at rates likely to be less phytotoxic.

## II. MATERIALS

azinphos methyl—A wettable powder containing 50% w/w active constituent.

carbaryl —A wettable powder containing 80% w/w active constituent.

diazinon —An emulsifiable concentrate containing 80% w/v active constituent.

dimethoate —A wettable powder containing 20% w/w active constituent.

maldison —A wettable powder containing 25% w/w active constituent.

methidathion —An emulsifiable concentrate containing 40% w/v active constituent.

omethoate —Emulsifiable concentrates containing 50% and 80% w/v active constituent.

parathion —An emulsifiable concentrate containing 50% w/v active constituent.

mineral oil —'Superior Summer Oil' containing 84% refined oils.
'Volck 70 Supreme Oil' containing 97% refined oils.
'Volck Supreme Oil' containing 98% refined oils.
White oil containing 80% refined oils.
Rd/33/4 and Rd/33/5—formulated by 'Ampol' containing 98% refined oils.

## III. METHODS

Trial layouts I to VI were randomized blocks (four replications, trials I, II and V; three replications, trials III, IV and VI) of single tree plots. Sprays were applied with a hand-held lance at a pressure of 1 000 to 1 400 kPa giving complete coverage with 14 to 23 litres of spray per tree. Wetting agent (Agral 60 (R)[1]) was used at the rate of 0·012% of spray where oil was omitted. Materials were tested against *A. aurantii* in trials I to VI and against *C. ficus* in trials I and IV. Trial VII was an unreplicated observation on the control of *A. aurantii* on a block of 97, 12-year-old Late Valencia oranges. Treatments were applied to a row or half-row of trees with a grower's oscillating boom at 2 800 kPa using 36 l of spray per tree.

Scale assessments were made on the fruit except for the pretreatment assessments in trial I and a post-treatment assessment in trial IV which were on the foliage and the pretreatment assessment in trials III and VII (also a post-treatment assessment in trial III) which were on the twigs. The usual procedure was to record the number of adult scales or second instar plus adult scales on 40 or 60 fruits per tree. A rating system was used to record the number of immature stages (first plus second instar scales) in trials I and II. This system was zero, 0 scales, one—1 or 2 scales, two—3 to 10 scales; three, 11 to 50 scales; and four, over 50 scales. In post-treatment assessments in trial VII (see Table 7),

## TABLE 1

TRIAL I—THE EFFECT OF INSECTICIDE TREATMENTS AGAINST *A. aurantii* ON LATE VALENCIA ORANGES AT BEERWAH 1969–70

| Treatment 21 Nov 69 and 5 Feb 70 | At Pre-treatment (3 Nov 69) per 20 Leaf Sample | | | At Post-treatment (3 Feb 70) per 40 Fruit Sample | | | At Post-treatment (20 May 70) per 40 Fruit Sample | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of Adult Scales | | Ratings of Immature Scales | No. of Adult Scales | | Ratings of Immature Scales | No. of Adult Scales | | Ratings of Immature Scales |
| | Trans. Means* | Equiv. Means** | Means | Trans. Means* | Equiv. Means** | Means | Trans. Means* | Equiv. Means** | Means |
| maldison 0·1% .. .. | 0·705 | 4·07 | 7·50a | 1·055a | 10·34 | 33·75a | 0·358a | 1·28 | 20·25a |
| white oil 2·5% .. .. | 0·520a | 2·31 | 5·00a | 1·155a | 13·28 | 23·50a | 0·301a | 1·00 | 2·25a |
| white oil 1% .. .. .. | 0·624 | 3·20 | 6·50a | 1·191a | 14·51 | 38·00a | 0·584a | 2·83 | 12·00a |
| carbaryl 0·075% .. .. | 0·345a | 1·21 | 3·75a | 1·671 | 45·92 | 75·00 | 1·805 | 62·84 | 91·25 |
| promecarb 0·075% .. .. | 0·075a | 0·19 | 4·00a | 1·298a | 18·44 | 56·50 | 0·897 | 6·90 | 39·75 |
| azinphos methyl 0·075% .. | 0·151a | 0·41 | 4·00a | 1·325a | 20·12 | 53·00 | 1·354 | 1·59 | 47·00 |
| omethoate 0·075% .. .. | 0·314a | 1·06 | 7·00a | 1·610 | 39·77 | 48·00 | 0·783 | 5·07 | 10·50a |
| methidathion 0·075% .. | 0·508a | 2·22 | 3·00a | 0·764a | 4·80 | 7·25a | 0·075a | 0·19 | 1·50a |
| no treatment .. .. .. | 0·464a | 1·91 | 2·00a | 1·587 | 37·68 | 72·50 | 1·316 | 19·72 | 84·50 |
| Necessary differences for significance 5% | 0·545 | | 6·01 | 0·616 | | 35·02 | 0·607 | | 30·54 |
| Necessary differences for significance 1% | 0·739 | | 8·14 | 0·834 | | 47·46 | 0·822 | | 41·39 |

* Log $_{10}$ (1 + x) transformation.

** Anti-transformed values.

a—denotes equality with the lowest treatment mean at the 5% level.

500, 1 000 or 2 000 fruit were assessed from each treatment, the number of fruit examined per tree being proportional to the number of trees in the treatment. In trial III, a pretreatment and post-treatment mortality count was made of 20 consecutive adult female scales and 10 randomly selected twigs per tree. The pretreatment counts gave a measure, at trial commencement, of the scale population and of the uniformity of infestation throughout the trial area.

Spray application and assessment times, localities and varieties are given in tables 1 to 9. In most cases, two sprays were applied 8 to 10 weeks apart during the period late November to mid February. A second post-treatment count was not made in trial II because of low scale numbers towards the conclusion of the trial and, accordingly, only the date of the first spray is given. One, two or three sprays were applied in trial VII.

## IV. RESULTS AND DISCUSSION

CONTROL OF A. AURANTII. Results for control of *A. aurantii* are given in tables 1 to 7. Methidathion and omethoate gave effective control used at 0·075% (in trials I, II and V) or 0·05% (in trials III, IV, VI and VII). Control by methidathion 0·05% was significantly improved in trials III and VII with the addition of 1% white oil. In trial VII, a single spray of methidathion 0·075% plus 1% white oil gave effective control, but not a single spray of methidathion 0·05% used alone. Effective control was also given by promecarb 0·075% plus 1% white oil (in trial II), promecarb 0·05% plus 1% white oil (in trial III) and azinphos methyl 0·05% plus 1% white oil (in trial III). However, these materials were ineffective when used without the addition of 1% white oil (in trials I, II and VII). Parathion was moderately effective at 0·075% (in trial V) and 0·05% (in trial IV) but unsatisfactory at 0·05% (in trial VII); dimethoate was moderately effective in trial III.

TABLE 2

TRIAL II—THE EFFECT OF INSECTICIDE TREATMENTS AGAINST *A. aurantii* ON LATE VALENCIA ORANGES AT PALMWOODS 1969–70

| Treatments (22 Dec. 69) | At Post-treatment (10 Feb., 70) per 40 Fruit Sample | | |
|---|---|---|---|
| | No. of Adult Scales | | Ratings of Immature Scales Means |
| | Trans. Means* | Equiv. Means** | |
| white oil 1% .. .. .. | 1·442 a | 26·64 | 67·00 |
| white oil 1·7% .. .. .. | 1·300 a | 20·09 | 65·50 |
| maldison 0·1% .. .. .. | 1·639 | 42·58 | 78·50 |
| carbaryl 0·075% .. .. .. | 2·193 | 155·05 | 120·25 |
| promecarb 0·075% .. .. .. | 2·008 | 100·76 | 110·75 |
| promecarb 0·075% + white oil 1% | 1·300 a | 18·93 | 62·50 a |
| azinphos methyl 0·075% .. .. | 1·886 | 75·97 | 95·50 |
| omethoate 0·075% .. .. .. | 1·005 a | 9·11 | 66·25 |
| methidathion 0·075% .. .. | 1·064 a | 10·59 | 44·00 a |
| no treatment .. .. .. | 2·260 | 181·00 | 128·25 |
| Necessary differences for significance 5% | 0·582 | | 20·72 |
| Necessary differences for significance 1% | 0·786 | | 27·98 |

* $\text{Log}_{10}(1 + x)$ transformation. ** Anti-transformed values.

a—denotes equality with the lowest treatment mean at the 5% level.

## TABLE 3

TRIAL III—THE EFFECT OF INSECTICIDE TREATMENTS AGAINST *A. aurantii* ON IMPERIAL MANDARINS AT MUNDUBBERA 1970–71

| Treatment 25 Nov 70 and 25 Jan 71 | At Pre-treatment (25 Nov 70) | | | At Post-treatment (24 Jan 71) | | | | At Post-treatment (6 Sept 71) | |
|---|---|---|---|---|---|---|---|---|---|
| | 200 Adult Female Sample on 10 Twigs % Living | per 40 Fruit Sample No. of 2nd Instar + Adult Scales | | 200 Adult Female Sample of 10 Twigs % Living | | per 40 Fruit Sample No. of Adult Scales | | per 60 Fruit Sample No. of Adult Scales | |
| | Means | Trans. Means* | Equiv. Means** | Trans. Means*** | Equiv. Means** | Trans. Means* | Equiv. Means** | Trans. Means* | Equiv. Means** |
| white oil 1% .. .. .. .. | 30·33a | 2·1665 | 145·72 | 0·304 | 8·95 | 1·605 | 39·23 | 2·728 | 533·02 |
| white oil 1·7% .. .. .. .. | 32·17a | 1·9553a | 89·22 | 0·229 | 5·14 | 0·845 | 5·99 | 1·895 | 77·54 |
| azinphos methyl 0·05% + white oil 1% | 36·67 | 2·0462a | 110·23 | 0·053a | 0·28 | 1·213 | 15·33 | 0·892a | 6·80 |
| summer superior oil 1·7% .. .. | 33·17a | 2·1454 | 138·78 | 0·158a | 2·48 | 0·664 | 3·61 | 1·739 | 53·84 |
| maldison 0·1% .. .. .. .. | 34·83a | 2·1757 | 148·85 | 0·146a | 2·12 | 1·353 | 21·53 | 2·401 | 250·78 |
| promecarb 0·05% + white oil 1% .. | 30·33a | 2·0152a | 102·56 | 0·047a | 0·22 | 0·000a | 0·00 | 0·943a | 7·77 |
| omethoate 0·05% .. .. .. | 29·67a | 2·0134a | 102·14 | 0·159a | 2·52 | 0·301a | 1·00 | 0·778a | 5·00 |
| dimethoate 0·05% .. .. .. | 32·83a | 2·1706 | 147·11 | 0·267 | 6·98 | 0·347a | 1·22 | 1·574 | 36·49 |
| diazinon 0·05% .. .. .. .. | 31·33a | 1·9963a | 98·15 | 0·370 | 13·10 | 1·314 | 19·63 | 2·584 | 382·54 |
| methidathion 0·05% .. .. .. | 31·50a | 2·1953 | 155·79 | 0·115a | 1·32 | 0·100a | 0·26 | 1·544 | 33·97 |
| methidathion 0·05% + white oil 1% | 31·67a | 2·1212 | 131·20 | 0·000a | 0·00 | 0·000a | 0·00 | 0·534a | 2·42 |
| no treatment .. .. .. .. | 29·00a | 1·8796a | 74·79 | 0·645 | 36·14 | 2·369 | 233·02 | 3·669 | 4 668·49 |
| Necessary differences for significance 5% .. | 7·04 | 0·2261 | | 0·166 | | 0·566 | | 0·798 | |
| Necessary differences for significance 1% | 9·57 | 0·3073 | | 0·226 | | 0·770 | | 1·085 | |

* Log $_{10}$ (1 + x) transformation.

** Anti-transformed values.

*** Inverse sine transformation.

a—denotes equality with the lowest treatment mean at the 5% level.

**TABLE 4**

TRIAL IV—THE EFFECT OF INSECTICIDE TREATMENTS AGAINST *A. aurantii* ON JOPPA ORANGES AT PALMWOODS 1971–72

| Treatment 1 Dec 71 and 15 Feb 72 | At Pre-treatment (30 Nov 71) per 60 Fruit Sample No. of 2nd Instar + Adult Scales | | At Post-treatment (14 Feb 72) per 40 Fruit Sample No. of Adult Scales | | At Post-treatment (6 June 72) per 60 Fruit Sample No. of Adult Scales | |
|---|---|---|---|---|---|---|
| | Trans. Means* | Equiv. Means** | Trans. Means* | Equiv. Means** | Trans. Means* | Equiv. Means** |
| summer superior oil 1·25% .. .. | 2·067a | 115·78 | 1·788 | 60·33 | 1·295a | 18·70 |
| summer superior oil 1·7% .. .. | 1·894a | 77·36 | 1·526 | 32·56 | 1·352a | 21·51 |
| volck 70 oil 1·25% .. .. .. | 2·139a | 136·68 | 1·562 | 35·48 | 1·898 | 78·10 |
| volck 70 oil 1% .. .. .. | 2·003a | 99·77 | 1·406 | 24·50 | 0·916a | 7·23 |
| volk supreme oil 1·25% .. .. | 2·125a | 132·35 | 0·840a | 5·91 | 1·276a | 17·88 |
| omethoate 0·05% .. .. .. | 2·112a | 128·41 | 1·131a | 12·54 | 0·731a | 4·38 |
| methidathion 0·05% .. .. .. | 1·883a | 75·42 | 0·619a | 3·16 | 0·360a | 1·29 |
| parathion 0·05% .. .. .. | 1·894a | 77·36 | 1·341a | 20·94 | 1·460a | 27·86 |
| no treatment .. .. .. .. | 2·265a | 183·02 | 2·421 | 262·39 | 1·518a | 31·96 |
| Necessary differences for significance 5% .. | 0·393 | | 0·784 | | 1·171 | |
| Necessary differences for significance 1% .. | 0·541 | | 1·080 | | 1·613 | |

* Log $_{10}$ (1 + x) transformation.

** Anti-transformed values.

a—denotes equality with the lowest treatment mean at the 5% level

## TABLE 5

TRIAL V—THE EFFECT OF INSECTICIDE TREATMENTS AGAINST *A. aurantii* ON MARSH SEEDLESS GRAPEFRUIT AT MUNDUBBERA 1971–72

| Treatment 7 Dec 71 and 8 Feb 72 | At Pre-treatment (7 Dec 71) per 40 Fruit Sample No. of 2nd Instar + Adult Scales | | At Post-treatment (21 Mar 72) per 40 Fruit Sample No. of Adult Scales | |
|---|---|---|---|---|
| | Trans. Means* | Equiv. Means** | Trans. Means*** | Equiv. Means** |
| summer superior oil 1·25% | 1·826a | 65·92 | 2·330 | 212·87 |
| summer superior oil 1·7% | 2·008a | 100·87 | 1·809 | 63·37 |
| volck 70 oil 1% | 2·123a | 131·74 | 1·481 | 29·24 |
| volck 70 oil 1·25% | 1·568a | 36·02 | 1·312 | 19·49 |
| volck supreme oil 1% | 2·278a | 188·47 | 1·989 | 96·56 |
| volck supreme oil 1·25% | 2·181a | 150·56 | 1·489 | 29·82 |
| white oil 1·25% | 1·887a | 76·11 | 1·662 | 44·89 |
| omethoate 0·075% | 2·314a | 204·99 | 0·305a | 1·02 |
| methidathion 0·075% | 1·895a | 77·47 | 1·465 | 28·15 |
| parathion 0·075% | 1·775a | 58·61 | 1·698 | 48·90 |
| no treatment | 1·968a | 91·87 | 3·547 | 3 523·42 |
| Necessary differences for significance 5% | 0·784 | | 1·007 | |
| Necessary differences for significance 1% | 1·056 | | 1·357 | |

* Log $_{10}$ (1 + x) transformation.

** Anti-transformed values.

*** Convariance analysis—$\log_{10}$ (1 + x) transformation.

a—denotes equality with the lowest treatment mean at the 5% level.

**TABLE 6**

TRIAL VI—THE EFFECT OF INSECTICIDE TREATMENTS AGAINST *A. aurantii* ON IMPERIAL MANDARINS AT MUNDUBBERA 1971–72

| Treatment 7 Dec 71 and 8 Feb 72 | At Pre-treatment (7 Dec 71) per 40 Fruit Sample No. of 2nd Instar + Adult Scales | | At Post-treatment (21 Mar 72) per 60 Fruit Sample No. of Adult Scales | |
|---|---|---|---|---|
| | Trans. Means* | Equiv. Means** | Trans. Means* | Equiv. Means** |
| summer superior oil 1·25% | 1·601a | 38·86 | 1·720 | 51·51 |
| summer superior oil 1·7% | 1·841a | 68·33 | 1·967 | 91·75 |
| volck 70 oil 1% | 1·255a | 16·99 | 1·829 | 66·40 |
| volck supreme oil 1% | 1·257a | 17·06 | 1·751 | 55·43 |
| white oil 1·25% | 1·480a | 29·22 | 1·309a | 19·36 |
| omethoate 0·05% | 1·591a | 38·02 | 1·164a | 13·57 |
| methidathion 0·05% | 1·451a | 27·24 | 0·840a | 5·91 |
| no treatment | 1·267a | 17·50 | 3·074 | 1 184·23 |
| Necessary differences for significance 5% | 0·589 | | 0·672 | |
| Necessary differences for significance 1% | 0·818 | | 0·933 | |

* $\text{Log}_{10}(1+x)$ transformation.

** Anti-transformed values.

a—denotes equality with the lowest treatment mean at the 5% level.

## TABLE 7

TRIAL VII—DEMONSTRATION OF THE EFFECT OF INSECTICIDE TREATMENTS AGAINST *A. aurantii* ON LATE VALENCIA ORANGES AT GAYNDAH 1972–73

| Treatment<br>(1) One spray—28 Nov 72<br>(2) Two sprays—28 Nov 72 and 1 Feb 73<br>(3) Three sprays—28 Nov 72, 19 Dec 72 and 1 Feb 73 | No. of Trees in Treatment | At Pre-treatment (27 Nov 72) (100 Twigs Sampled per Treatment) No. of Adult Scales per Twig | At Post-treatment | |
|---|---|---|---|---|
| | | | (26 Apr 73) (500 Fruit Sampled per Treatment) No. of Adult Scales per Fruit | (3 Aug 73) ((x) 2000 Fruit Sampled per Treatment— (y) 1000 Fruit (z) 500 Fruit) No. of Adult Scales per Fruit |
| methidathion 0·05% (1) | 10 | 3·34 | 1·91 | 1·820x |
| methidathion 0·05% (2) | 11 | 3·04 | 1·45 | 0·770x |
| parathion 0·05% (2) | 11 | 2·34 | 1·91 | 3·555x |
| omethoate 0·05% (2) | 11 | 3·46 | 0·06 | 0·024x |
| azinphos methyl 0·05% (2) | 5 | 2·07 | 6·50 | 6·300z |
| volck 70 oil 1·25% (3) | 6 | 0·70 | 0·00 | 0·000x |
| rd/33/5 oil 1·25% (3) | 11 | 2·38 | 0·00 | 0·006x |
| methidathion 0·05% + white oil 1% (2) | 11 | 0·50 | 0·12 | 0·003x |
| rd/33/4 oil 1·25% (3) | 7 | 0·47 | 0·00 | 0·000x |
| white oil 1·7% (3) | 4 | 0·22 | 0·00 | 0·475y |
| methidathion 0·075% + white oil 1% (1) | 6 | 2·87 | 0·68 | 0·360x |
| no treatment | 4 | 0·65 | 18·28 | 28·780z |

## TABLE 8

TRIAL I—THE EFFECT OF INSECTICIDE TREATMENTS AGAINST *C. ficus* ON LATE VALENCIA ORANGES AT BEERWAH 1969–70

| Treatment 21 Nov 69 and 5 Feb 70 | At Pre-treatment (3 Nov 69) per 20 Leaf Sample | | | At Post-treatment (3 Feb 70) per 40 Fruit Sample | | | At Post-treatment (20 May 70) per 40 Fruit Sample | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. of Adult Scales | | Ratings of Immature Scales | No. of Adult Scales | | Ratings of Immature Scales | No. of Adult Scales | | Ratings of Immature Scales |
| | Trans. Means* | Equiv. Means** | Means | Trans. Means* | Equiv. Means** | Means | Trans. Means* | Equiv. Means** | Means |
| maldison 0·1% | 1·703a | 49·50 | 23·75a | 1·012 | 9·29 | 31·75a | 1·216 | 15·45 | 42·50 |
| white oil 2·5% | 1·590a | 37·91 | 21·50a | 0·530a | 2·39 | 14·25a | 0·728a | 4·34 | 7·00a |
| white oil 1% | 2·249 | 176·39 | 33·25 | 1·015 | 9·36 | 45·75 | 1·039a | 9·93 | 32·00a |
| carbaryl 0·075% | 1·680a | 46·86 | 21·75a | 1·518 | 31·94 | 74·00 | 2·556 | 358·75 | 125·25 |
| promecarb 0·075% | 1·590a | 37·88 | 23·50a | 1·170 | 13·78 | 48·75 | 1·583 | 37·32 | 69·75 |
| azinphos methyl 0·075% | 1·549a | 34·41 | 20·75a | 1·309 | 19·35 | 58·75 | 2·243 | 174·04 | 83·50 |
| omethoate 0·075% | 1·946a | 87·38 | 20·75a | 0·450a | 1·82 | 5·25a | 0·540a | 2·46 | 14·50a |
| methidathion 0·075% | 1·891a | 76·85 | 28·25a | 0·175a | 0·50 | 4·50a | 0·325a | 1·11 | 1·75a |
| no treatment | 1·845a | 69·01 | 21·00a | 1·499 | 30·56 | 66·50 | 1·975 | 93·37 | 105·25 |
| Necessary differences for significance 5% | 0·583 | | 11·49 | 0·573 | | 28·21 | 0·717 | | 35·58 |
| Necessary differences for significance 1% | 0·790 | | 15·57 | 0·695 | | 38·23 | 0·971 | | 48·21 |

* $\text{Log}_{10}(1+x)$ transformation.

** Anti-transformed values.

a—denotes equality with the lowest treatment mean at the 5% level.

## TABLE 9

TRIAL IV—THE EFFECT OF INSECTICIDE TREATMENTS AGAINST *C. ficus* ON JOPPA ORANGES AT PALMWOODS 1971–72

| Treatment 1 Dec 71 and 15 Feb 72 | At Pre-treatment (30 Nov 71) per 60 Fruit Sample No. of Adult Scales | | At Post-treatment (14 Feb 72) per 40 Fruit Sample No. of Adult Scales | | At Post-treatment (14 Feb 72) per 40 Leaf Sample No. of Adult Scales | | At Post-treatment (6 May 72 per 60 Fruit Sample No. of Adult Scales | |
|---|---|---|---|---|---|---|---|---|
| | Trans. Means* | Equiv. Means** | Trans. Means* | Equiv. Means** | Trans. Means* | Equiv. Means** | Trans. Means* | Equiv. Means** |
| summer superior oil 1·25% .. .. | 2·161 | 143·82 | 1·791 | 60·86 | 1·006 | 9·14 | 2·145 | 138·62 |
| summer superior oil 1·7% .. .. | 2·135 | 135·52 | 1·651 | 43·77 | 1·122 | 12·25 | 2·349 | 222·45 |
| volck 70 oil 1·25% .. .. .. | 2·344 | 219·62 | 1·528 | 32·71 | 0·918a | 7·28 | 2·501 | 315·96 |
| volck 70 oil 1% .. .. .. | 2·055 | 112·53 | 1·188 | 14·40 | 1·134 | 12·61 | 2·075 | 117·97 |
| volck supreme oil 1·25% .. .. | 1·965 | 91·20 | 0·968 | 8·28 | 0·000a | 0·00 | 1·481 | 29·28 |
| omethoate 0·05% .. .. .. | 1·718a | 51·18 | 0·201a | 0·59 | 0·159a | 0·44 | 0·233a | 0·71 |
| methidathion 0·05% .. .. .. | 1·251a | 16·83 | 0·000a | 0·00 | 0·100a | 0·26 | 0·159a | 0·44 |
| parathion 0·05% .. .. .. | 1·873a | 73·58 | 0·282a | 0·91 | 0·201a | 0·59 | 1·509 | 31·30 |
| no treatment .. .. .. .. | 1·639a | 42·57 | 1·968 | 91·86 | 1·740 | 53·93 | 2·634 | 429·89 |
| Necessary differences for significance 5% .. | 0·703 | | 0·809 | | 0·988 | | 0·863 | |
| Necessary differences for significance 1% .. | 0·969 | | 1·114 | | 1·361 | | 1·190 | |

* $\text{Log}_{10}(1+x)$ transformation.

** Anti-transformed values.

a—denotes equality with the lowest treatment mean at the 5% level.

The most effective oil treatments were 2·5% and 1% white oil (in trial I), 1·25% white oil (in trial VI), 1% and 1·25% 'Volck 70' oil (in trial V) and 1·25% 'Volck Supreme' oil (in trials IV and V). White oil at 1·7%, 'Volck 70' oil at 1·25%, Rd/33/4 at 1·25% and Rd/33/5 at 1·25% each applied three times gave effective control in trial VII. No phytotoxic effects were observed in trials I to VI. However, all four treatments in which oil was used alone in trial VII caused noticeable leaf drop, reduction in fruit size and colour retardation. The temperature was 32°C when the second of the three sprays was applied and the following week it rose to 43°C.

Low strength oil treatments (1% to 1·25%) were less consistent than methidathion or omethoate, particularly in trials III and V where high infestation pressure occurred. They may be of value, however, in an integrated control programme where it is necessary to restrict the use of organic insecticides. Differences between similar strength oil formulations were not significant, although white oil appeared to be slightly more effective than 'Summer Superior' oil in trials V and VI.

CONTROL OF *C. ficus*. Results of trials I and IV on *C. ficus* are given in tables 8 and 9. Methidathion and omethoate 0·075% (in trial I) or 0·05% (in trial IV) and 2·5% white oil (in trial I) gave effective control. White oil at 1% was significantly more effective than carbaryl, promecarb and azinphos methyl in trial I, but other oil treatments except 1·25% 'Volck Supreme' oil (in trial IV) were unsatisfactory. Carbaryl and to a lesser extent azinphos methyl caused a scale build up in trial I, probably due to a combination of low efficacy against the scale and high toxicity to natural enemies.

## V. ACKNOWLEDGEMENTS

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