Efficacy of Insecticide to Citrus Thrips on Lemons in the Low Desert Areas of Arizona[1]

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Abstract

New chemistries (Alert, Success, Fipronil, Ni-25, Nexter, Danitol and Baythroid) were evaluated and compared with standard chemistries (Agri-Mek, Dimethoate and Carzol) for control of citrus thrips in lemons grown in the Yuma area. Additionally, Success was compared to Carzol in a large plot commercial demonstration. Under cool, early season conditions, all products appeared to offered good thrips control. However, under warmer conditions, Nexter, Danitol, Baythroid and Dimethoate appear weak. Among the new insecticides, Success and Fipronil appear most efficacious. Alert also appeared to have good activity at the high rate, but appeared to offer shorter residual control than Fipronil or Success. Fipronil was the only new product tested that flared mites. However, rotating sulfur into the Fipronil applications appeared to help prevent flaring. Growers can expect Baythroid and Danitol to behave similarly to Dimethoate for efficacy and residual control. Under commercial conditions, Success provided thrips control equivalent to Carzol at 1.38 lbs-ai/A.

Introduction

[1]Citrus thrips, CT, *Scirtothrips citri* (Moulton), is the most severe insect pest attacking citrus in the low desert areas of Arizona, and are far have the more severe than elsewhere in the United States. Presently, pest control advisors (PCA's) and growers rely primarily on Carzol, Agri-Mek or Dimethoate, often tank-mixed with Lannate or other insecticides for control of this pest. Although these products have proved efficacious under cool conditions, except for Carzol, they will often provide only knockdown control and suppression under hot conditions. Recent investigations suggest that insecticide resistance may be a contributing factor in poor insecticidal control. Additionally, there is concern that highly toxic and non-specific products such as Lannate and other carbamate and organophosphorus insecticides, are being targeted by the Environmental Protection Agency for discontinuation. Identifying alternative control measures for CT control is critical.

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Within recent years, several new insecticides have begun development for CT control in citrus. Unlike many of the products developed in the past, these insecticides tend to be more target specific and more mundane to the environment. Alert, chlorfenapyr (American Cyanamid), is in a novel class of insecticide and has a unique mode of action. It acts as a mitochondrial poison, and disrupts the electron transport chain. Basically, it shuts down the insects' power generating capabilities. Although Alert has contact activity and a rapid knockdown, it is most toxic after consumption. Once ingested, the insects convert the molecule into a more toxic structure. Alert is translaminar and will move into the leaf tissue where contacted, but is not systemic. Alert appears to be toxic to a broad range of lepidopterous pests, thrips and mites. Fipronil (Rhone Poulenc), is a unique phenyl pyrazole, and acts by binding to and blocking the GABA site of the insect's nerve. Fipronil is noted for its activity towards thrips, lygus and other sucking pests. Ni-25, acetamiprid, is another new product being developed by Rhone Poulenc. It belongs to the chloronicotynl class of insecticides which also includes Admire and Provado imidacloprid (Bayer). Although, this class of chemistry is noted for its activity towards whiteflies and aphids when applied as a soil treatment, when foliarly applied they will move into the leaf tissue, and have demonstrated some activity to thrips. Success, spinosad (Dow), is a fermentation by-product produced by the bacterium *Saccharopolyspora spinosa*. Success has demonstrated good activity against a broad range of lepidopterous pests, leafminers and thrips. Like Alert, it has translaminar activity and will move into the leaf tissue, and is most active after ingestion. It is thought to act at the GABA site and also at the nicotinic receptor on the nerve synapse. Success is very safe to beneficial insects and is low in toxicity to mammals. Nexter, pyridaben, is a new product just recently registered for use in citrus. It belongs to the pyridazinone family of insecticides and acts similarly to Alert. Nexter is a noted miticide but has also demonstrated activity toward whiteflies, aphids and thrips.

Other products of interest include Baythroid and Danitol. Baythroid, cyfluthrin, is a pyrethroid produced by Bayer that has been used for several years in California for CT control under a Section 18, but has recently been granted a full federal registration for use in citrus. Danitol, fenpropathrin, is another pyrethroid produced by Valent with registrations pending in citrus. Danitol was used in Arizona for CT control for several years under a Section 18 registration prior to the registration of Agri-Mek.

The purpose of this research was to evaluate the efficacy new insecticides and insecticide currently available for CT control, for their potential for use in the unique growing conditions of the low desert citrus production areas of Arizona. The following report represents CT control data collected from 1995 and 1996 from four separate small plot efficacy trials, and from one large plot Success demonstration.

Materials and Methods

Small plot efficacy trials

Eight-year-old lemon trees owned by Glen Curtis Inc. in Yuma, AZ were treated with insecticides for control of CT in four separate efficacy trials, two in 1995 and two in 1996. All small plot tests were randomized complete block designs consisting of four replicates. Each plot (30 ft by 90 ft) consisted of three trees in a row spaced 30 ft apart. Applications were made using a backpack air-blast sprayer calibrated to deliver 100 gal/acre.

Temperature data was obtained from the AZMET weather database system, from the weather station located at the University of Arizona Yuma Mesa Station, ca. 300-yd from the test site. Temperature data are presented as an average temperature in F for each 24-hr period following the most recent insecticide application. Percent-infested fruit were estimated by sampling ten fruit per tree for the presence or absence of immature CT. Fruit damage was estimated on by rating the degree of scarring to the rind. Scarring was rated as 1=no scarring, 2=slight scarring around the calyx, 3=significant scarring around the calyx, 4=slight scarring on the side of the fruit and 5=major scarring on the side of the fruit. Percentage fruit infested with immature CT were transformed using a square-root transformation for analysis, percentage values are presented in the tables. Differences among treatments were separated using ANOVA and an F protected LSD.

Danitol Test, 1995

Danitol was evaluated for its efficacy when used alone or tank-mixed with Carzol. Treatments included Danitol at 0.4 lb.-ai/A, Carzol at 0.92 and 1.38 lbs-ai/A, Danitol at 0.2 lbs-ai/A + Carzol at 0.92 lbs-ai/A, and Microthiol sulfur at 10 lbs/A. Following the first applications Butacide (PBO) at 0.25 lbs-ai/A was included with the Danitol alone treatment as a synergizer. Applications were initiated approximately seven days after petal fall. All treatment applications included Kinetic spreader-sticker at 0.1% v/v. Treatments were applied on Mar 31, May 6 and May 21. Evaluations were made on Apr 4, Apr 7, Apr 14, Apr 21, Apr 28, May 5, May 8, May 12, May 19, May 23 and May 30.

Experimentals, 1995

Experimental insecticides were evaluated for their potential against CT on lemons. Treatments included Fipronil at 0.15 lbs-ai/A, Success at 0.11, 0.22 and 0.44 lbs-ai/A, Alert at 0.10, 0.15 and 0.30 lbs-ai/A and Provado at 0.10 lbs-ai/A. Agri-Mek was included as a standard at 10 oz/A. However, Agri-Mek was rotated with Veratrin at 15 lbs/A + sugar at 5 lbs/A, to simulate a soft approach to CT control. Alert at 0.30 lbs-ai/A was applied at the first application only. Applications were initiated approximately seven days after petal fall. All treatment applications except Agri-Mek included Kinetic spreader-sticker at 0.1% v/v. Agri-Mek was applied with NR-415 petroleum spray oil at 1.0% v/v. Treatments were applied on Mar 27, Apr 29 and May 15. Evaluations were made on Mar 29, Apr 3, Apr 10, Apr 17, Apr 24, May 1, May 5, May 12, May 17 and May 22. In addition to CT infestation counts, on May 22, twospotted spider mites (TSM) *Tetranychus urticae* Koch densities were estimated by counting the number of TSM infesting 10 fruit per tree.

Pyrethroid / Agri-Mek Test, 1996

Danitol was evaluated in at two rotation regimes, and Baythroid was evaluated alone and in combination with Carzol. Additionally, Agri-Mek was evaluated and normal and reduced rates. Baythroid was used at 0.1 lbs-ai/A and at 0.05 lbs-ai/A + Carzol at 0.92 lbs-ai/A. Carzol was also evaluated alone at 1.38 lbs-ai/A. Agri-Mek was used at 10.0 and 5.0 oz/A. Danitol was applied at the first application only, at 0.4 lbs-ai/A for both rotation regimes. For the second applications, Regime 1 was treated with Agri-Mek at 10.0 oz/A, while Regime 2 was treated with Alert at 0.2 lbs-ai/A. Both Regimes received Dimethoate at 1.5 pt./A for the third application. Applications were initiated approximately 14 days after petal fall. Treatments were applied on Apr 3, Apr 30 and May 15. Evaluations were made on Apr 5, Apr 9, Apr 15, Apr 23, Apr 29, May 2, May 6, May 13, May 17, May 20 and May 29.

Experimentals, 1996

Fipronil was evaluated alone at 0.15 lbs-ai/A the first and third applications, The second application included Microthiol at 10 lbs/A to help prevent flaring of mites. Ni-25 was sprayed at 0.075 lbs-ai/A, Success was applied at 0.09 and 0.14 lbs-ai/A, Alert was treated at 0.2 and 0.3 lbs-ai/A, Nexter was sprayed at 0.2, 0.3 and 0.4 lbs-ai/A, and Carzol at 1.38 lbs-ai/A. Applications were initiated approximately seven days after petal fall. Treatments were applied on Apr 2, Apr 23 and May 08. Evaluations were made on Apr 4, Apr 9, Apr 15, Apr 23, Apr 25, Apr 29, May 6, May 10, May 13, May 20 and May 29.

Success demonstration

Success was evaluated under a crop-destruct experimental use permit, under commercial field conditions in a 120 acre grove of mature, large lemon trees managed by Spencer and Spencer. The demonstration was designed as a strip plot test with pseudoreplication. One acre of trees was treated with Success at 0.132 lbs-ai/A, and another 0.5 acres was left untreated. The remainder of the grove was treated with a Carzol at 1.38 lbs-ai/A + LeafAct 80 BS at 0.125%v/v.. The entire grove was treated with Dimethoate shortly after petal fall on 04/03/97, and because of cool conditions didn't require re-treatment until early May. Subsequent applications of Success and Carzol were made

on 03 May and 01 Jun. Applications were made using a standard commercial speed sprayer calibrated to deliver 50 gal/A.

Evaluations were made by sampling 10 fruit per tree, and counting the number of fruit infested with immature CT. Ten trees were sampled in each treatment regime. Evaluations were made on 03, 07, 10, 17, 24 and 31 May, 04, 07 and 14 Jun. Fruit damage was estimated on 19 Aug by rating the degree of scarring to the rind. Scarring was rated as 1=no scarring, 2=slight scarring around the calyx, 3=significant scarring around the calyx, 4=slight scarring on the side of the fruit and 5=major scarring on the side of the fruit.

Results and Discussion

Small plot efficacy trials

Danitol Test, 1995

Precounts indicated that CT populations just prior to the first application were averaging 16.67 % infested fruit across all plots. Immediately following the first applications temperatures became cool averaging ca. 67 F and CT populations dropped (Table 1). Because of the low temperatures following application 1, differences among treatments were difficult to discern. However, Carzol and Carzol + Danitol appeared to provide the best control. Microthiol and Danitol alone did not differ from the untreated, but the untreated was averaging only 9.16 % infested fruit, which is a sub-economical infestation. Differences among treatments following application 1 were also detected on 5 May (35 DAT), but none of the treatments were offering acceptable control.

Temperatures and CT populations remained fairly low relative to historical averages following the second application (Table 2). At application 2, Buticide was included with Danitol in an attempt to synergize its activity, but did not seem to have much effect. Danitol and Microthiol did not reduce CT populations relative to the untreated, while treatments containing Carzol provided good control. Carzol at 1.38 lb.-ai/A maintained CT populations below 10 %, throughout the evaluation period, while Carzol at 0.92 lbs-ai/A, with or without Danitol had broken by 13 DAT.

Following the third application, temperatures increased ca. 10 F, and CT populations rose (Table 3). At 2 DAT, only those treatments containing Carzol reduced CT populations to <10%. By 9 DAT, the Carzol alone treatments were still providing adequate control, while the other treatments would have required re-treatment. However, the majority fruit size at this point was 2.0 in. in diameter or greater, and no longer susceptible to CT damage.

Low CT populations in this test probably resulted in lower scarring damage than would be expected in a normal year. Microthiol was the only treatment that did not reduce fruit scarring relative to the untreated (Table 3). Tank mixing Carzol and Danitol did not offer better CT control than Carzol alone.

Experimentals, 1995

Precount taken immediately before the first application indicated that CT populations were averaging 20.0 % infested fruit. Immediately following the first applications temperatures became cool averaging ca. 65 F, and CT populations dropped (Table 4). All treatments evaluated provided good control of CT, and control lasted for approximately 30 days.

Application 2 was made on Apr 29 and average temperatures were ca. 10 F higher than those following the first application (Table 5). The single application (application 1) of Alert at 0.3 lbs-ai/A was not providing control at this point. Control with Fipronil and Success lasted at least 13 days, while Alert lasted only 1 wk. Provado and Vertrin (rotated with Agri-Mek) did not provide good control.

Following application 3, temperatures were relatively high, averaging 84 F in the 6 days following the application (Table 6). Under hot conditions, Fipronil and Success provided good control of CT, Alert , Provado and Agri-Mek did not perform well.

Due to low CT pressure, fruit scarring was low across all treatments (Table 6). However, some differences among treatments were detected. Fipronil and Success were best at preventing fruit scarring. A single application of Alert at 0.3 lbs-ai/A and Agri-Mek rotated with Veratrin did not provide adequate protection. Provado and regular applications of Alert offered moderate fruit protection. It was obvious that rates of Alert at 0.1 or 0.15 lbs-ai/A would not be adequate for CT control in the Yuma area under hot conditions, the 0.3 lbs-ai/A rate will probably have to be used.

Pyrethroid / Agri-Mek Test, 1996

Precounts were taken on Apr 1, plots averaged 17.29 percent infested fruit, and did not differ among treatments. However, following the first application, temperatures became cool and CT populations dropped (Table 7). All treatments except Danitol, Baythroid and the half-rate of Agri-Mek provided good knockdown. After CT populations crashed, CT populations remained low in all treatments until Apr 29.

Temperatures remained below normal following the second application (Table 8). Treatments containing Carzol or back-to-back applications (with at least a 30 day interval) of Agri-Mek continued to provide good control, lasting at least 2 wk. However, where Agri-Mek followed Danitol, CT populations were greater than where Agri-Mek at 10 oz was used both applications, suggesting that Danitol's lack of performance in application 1, influenced Agri-Mek's control in the second application, probably because Danitol did not disrupt CT populations enough to prevent overlapping generations. Baythroid offered 7-10 days of CT control.

Under the hot conditions experienced following application 3, treatments containing Carzol or Agri-Mek at the 10 oz rate, provided good CT control for ca. 2 wk (Table 9). Baythroid alone and Dimethoate alone offered only suppression of CT, and Agri-Mek at 5 oz provide moderate control.

Low CT populations, especially early in the season, resulted in low incidences of fruit scarring (Table 9). Fruit scarring among all insecticide treatments were lower than the untreated, and did not differ from each other. Tank mixing Baythroid at a half-rate with Carzol at 0.92 lb.-ai/A appeared to provided control equal to Carzol at 1.38 lbs-ai/A, and superior control to Baythroid at a full-rate. Using Agri-Mek at a half-rate had questionable utility in the Yuma area.

Experimentals, 1996

Precounts were taken on Mar 29, infested fruit averaged 11.87 percent and did not differ among treatments. Immediately following the first application, cool temperatures kept CT populations low for most of the month of April (Table 10). All treatments, except Nexter provided good CT knockdown. However, by 7 DAT, Nexter was providing control equivalent to the other treatments.

Application 2 was made on Apr 23, and temperatures following this application were ca. 10 F greater than following the first application (Table 11). At 2 DAT, all treatments evaluated provided good CT knockdown. However by 6 DAT, Nexter had broken. Fipronil, and Success were the only products that appeared to offer more than 2 wk control.

After application 3, temperatures were hot and Nexter provided little CT control (Table 12). Alert was providing adequate control 21 DAT, but appeared to be beginning to break. Fipronil, Success and Carzol were providing the best control, followed by Ni-25.

Low CT populations, especially early in the season, resulted in low incidences of fruit scarring (Table 12). Fruit scarring among all insecticide treatments were lower than the untreated, and did not differ from each other. These data suggest that early-season of CT when fruit is small 1.0 in. in diameter may be more critical than protecting

fruit 1.5-2.0 in. in diameter. Ni-25, Fipronil, Success and Alert all appear to offer good CT control. Nexter may have utility if applied when temperatures are expected to be cool.

Table 1. Danitol Test, 1995. Percentage of fruit infested with immature CT on lemons following application 1, Mar 31, 1995.

First application		Mean percentage fruit infested with immature CT					
Treatments[a]	Rate lbs(AI)/acre	Apr 4 4 DAT[c] (67.2 F)	Apr 7 7 DAT (68.6 F)	Apr 14 14 DAT (67.9 F)	Apr 21 21 DAT (65.0 F)	Apr 28 28 DAT (66.9 F)	May 5 35 DAT (68.1 F)
Carzol SP	0.92	5.84 a	1.67 d	4.17 a	0.83 a	5.00 a	50.00 ab
Carzol SP	1.38	3.33 a	2.50 cd	0.83 a	1.67 a	2.50 a	37.50 bc
Danitol[b]	0.4	6.67 a	5.83 abc	7.50 a	0.83 a	7.50 a	50.83 a
Microthiol	10 lb./acre	9.16 a	7.50 ab	13.34 a	0.83 a	6.67 a	47.50 ab
Carzol + Danitol	0.92 + 0.2	7.50 a	3.33 bcd	2.50 a	1.67 a	8.33 a	28.34 c
Untreated	--	12.50 a	9.16 a	10.00 a	5.00 a	6.67 a	51.67 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation. Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v. Applications containing Carzol included Neutralizer buffer at 0.125% v/v.

[b]Danitol was applied alone on the first application, and tank-mixed with Butacide on applications two and three.

[c]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 2. Danitol Test, 1995. Percentage of fruit infested with immature CT on lemons following application 2, May 6, 1995.

Second application		Mean percentage fruit infested with immature CT		
Treatments[a]	Rate lbs(AI)/acre	May 8 2 DAT[c] (65.0 F)	May 12 6 DAT (67.6 F)	May 19 13 DAT (68.8 F)
Carzol SP	0.92	5.00 c	15.00 b	26.67 b
Carzol SP	1.38	4.17 c	8.34 b	6.67 c
Danitol + Butacide[b]	0.4 + 0.25	30.00 b	35.83 a	40.83 a
Microthiol	10 lb./acre	42.50 a	53.33 a	45.00 a
Carzol + Danitol	0.92 + 0.2	6.67 c	6.66 b	16.67 b
Untreated	--	39.17 ab	45.00 a	55.00 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation. Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v. Applications containing Carzol included Neutralizer buffer at 0.125% v/v.

[b]Danitol was applied alone on the first application, and tank-mixed with Butacide on applications two and three.

[c]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 3. Danitol Test, 1995. Percentage of fruit infested with immature CT on lemons and fruit following application 3, May 21, 1995, and end of season fruit scarring ratings.

Third application		Mean percentage fruit infested with immature CT		Fruit scarring
Treatments[a]	Rate lbs(AI)/acre	May 23 2 DAT[c] (77.7 F)	May 30 9 DAT (77.0 F)	Jul 18 Mature fruit
Carzol SP	0.92	1.67 d	7.50 b	1.42 b
Carzol SP	1.38	1.67 d	9.17 b	1.43 b
Danitol + Butacide[b]	0.4 + 0.25	47.50 a	38.33 a	1.52 b
Microthiol	10 lb./acre	25.00 b	34.17 a	2.00 a
Carzol + Danitol	0.92 + 0.2	8.34 c	12.50 b	1.43 b
Untreated	--	50.84 a	43.33 a	1.97 a

Means in a column followed by the same letter are not significantly different (F protected LSD P < 0.05) after square-root transformation (percentage infested fruit data only). Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v. Applications containing Carzol included Neutralizer buffer at 0.125% v/v.

[b]Danitol was applied alone on the first application, and tank-mixed with Butacide on applications two and three.

[c]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 4. Experimentals, 1995. Percentage of fruit infested with immature CT on lemons following application 1, Mar 27, 1995.

First application		Mean percentage fruit infested with immature CT				
Treatments[a]	Rate lbs(AI)/acre	Mar 29 2 DAT[d] (60.67 F)	Apr 3 7 DAT (64.0 F)	Apr 10 14 DAT (66.2 F)	Apr 17 21 DAT (65.4 F)	Apr 24 28 DAT (65.1 F)
Fipronil	0.15	1.67 d	6.67 d	1.67 a	0.00 a	0.00 a
Success	0.11	3.33 bcd	6.66 ab	3.33 a	2.50 a	5.00 a
Success	0.22	8.34 abc	5.00 b	5.00 a	4.17 a	2.50 a
Success	0.44	4.17 bcd	7.50 ab	0.83 a	0.00 a	5.84 a
Alert	0.10	10.00 ab	3.33 b	2.50 a	4.17 a	3.34 a
Alert	0.15	7.50 cd	2.50 b	2.50 a	4.17 a	5.83 a
Alert[b]	0.30	3.34 bcd	2.50 b	2.50 a	4.17 a	2.50 a
Provado	0.10	5.83 bcd	3.33 b	5.00 a	3.33 a	4.17 a
Agri-Mek[c]	10 oz/acre	3.34 cd	3.33 b	2.50 a	4.17 a	5.00 a
Untreated	--	16.67 a	13.34 a	6.67 a	5.00 a	10.00 a

Means in a column followed by the same letter are not significantly different (F protected LSD P < 0.05) after square-root transformation. Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v except Agri-Mek that included NR-415 petroleum oil at 1.0 gal/acre.

[b]Treatment was applied at first application only.

[c]First and third applications were Agri-Mek, second was Veratrin.

[d]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 5. Experimentals, 1995. Percentage of fruit infested with immature CT on lemons following application 2, Apr 29, 1995.

Second application		Mean percentage fruit infested with immature CT		
Treatments[a]	Rate lbs(AI)/acre	May 1 2 DAT[d] (78.0 F)	May 5 6 DAT (73.0 F)	May 12 13 DAT (70.3 F)
Fipronil	0.15	2.50 bc	6.67 d	5.00 d
Success	0.11	1.67 c	7.50 d	5.00 d
Success	0.22	2.50 bc	8.34 d	2.50 d
Success	0.44	0.83 c	2.50 d	7.50 d
Alert	0.10	3.33 b	23.33 c	23.34 bc
Alert	0.15	8.33 bc	25.84 c	19.17 c
Alert[b]	0.30	23.33 a	39.17 bc	33.33 abc
Provado	0.10	15.83 a	33.34 c	25.00 bc
Veratrin + sugar[c]	15 lb./acre + 5 lb./acre	20.83 a	54.16 ab	32.50 ab
Untreated	--	24.17 a	61.67 a	48.33 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation. Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v.

[b]Treatment was applied at first application only.

[c]First and third applications were Agri-Mek, second was Veratrin.

[d]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 6. Experimentals, 1995. Percentage of fruit infested with immature CT and TSM on lemons following application 3, May 15, 1995, and end of season fruit scarring ratings.

Third application		Mean percentage fruit infested with immature CT		Mean no. TSM/fruit	Fruit scarring
Treatments[a]	Rate lbs(AI)/acre	May 17 2 DAT[d] (68 F)	May 22 6 DAT (84.3 F)	May 22 6 DAT	Jul 13 Mature fruit
Fipronil	0.15	1.67 de	2.50 d	43.42 b	1.06 c
Success	0.11	4.17 cde	8.33 cd	4.47 a	1.27 c
Success	0.22	1.67 de	1.67 d	4.64 a	1.22 c
Success	0.44	0.00 e	7.50 cd	3.92 a	1.14 c
Alert	0.10	7.50 cd	14.17 cd	2.72 a	1.64 b
Alert	0.15	4.17 cde	19.17 bc	2.67 a	1.50 bc
Alert[b]	0.30	28.33 a	45.83 a	0.22 a	2.18 a
Provado	0.10	7.50 cd	39.17 ab	4.34 a	1.78 b
Agri-Mek[c]	10 oz/acre	11.67 bc	21.82 cd	0.45 a	2.01 ab
Untreated	--	29.17 a	49.17 a	0.89 a	2.29 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation (percentage infested fruit data only). Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v except Agri-Mek that included NR-415 petroleum oil at 1.0 gal/acre.

[b]Treatment was applied at first application only.

[c]First and third applications were Agri-Mek, second was Veratrin.

[d]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 7. Pyrethroid / Agri-Mek Test, 1996. Percentage of fruit infested with immature CT on lemons following application 1, Apr 3, 1996.

First application		Mean percentage fruit infested with immature CT				
Treatments[a]	Rate lbs(AI)/acre	Apr 5 2 DAT[d] (69.0 F)	Apr 9 6 DAT (71.0 F)	Apr 15 12 DAT (70.2 F)	Apr 23 20 DAT (70.5 F)	Apr 29 26 DAT (72.6 F)
Carzol SP	1.38	0.83 d	2.50 bc	2.50 a	1.67 b	13.34 a
Carzol + Baythroid	0.92 + 0.05	0.83 d	0.83 c	0.83 a	4.17 b	15.84 a
Baythroid	0.1	8.34 bcd	5.83 bc	1.67 a	1.67 b	14.17 a
Agri-Mek	0.04	7.50 bcd	4.17 bc	0.00 a	3.33 b	13.33 a
Agri-Mek	0.08	1.67 d	0.00 c	2.50 a	7.50 b	10.00 a
Danitol[b]	0.4	21.67 a	5.83 bc	4.17 a	6.67 b	24.17 a
Danitol[c]	0.4	10.84 bc	16.67 a	4.17 a	5.00 b	22.50 a
Untreated	--	14.17 ab	8.33 b	6.67 a	16.67 a	19.17 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation. Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v except Agri-Mek that included NR-415 petroleum oil at 1.0 gal/acre. Applications containing Carzol included Neutralizer buffer at 0.125% v/v.

[b]Danitol was applied the first application, Agri-Mek the second and Dimethoate E267 the third.

[c]Danitol was applied the first application, Alert the second and Dimethoate E267 the third.

[d]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 8. Pyrethroid / Agri-Mek Test, 1996. Percentage of fruit infested with immature CT on lemons following application 2, Apr 30, 1996.

Second application		Mean percentage fruit infested with immature CT		
Treatments[a]	Rate lbs(AI)/acre	May 2 2 DAT[d] (79.0 F)	May 6 6 DAT (67.7 F)	May 13 13 DAT (74.6 F)
Carzol SP	1.38	2.50 b	1.67 d	2.50 d
Carzol + Baythroid	0.92 + 0.05	2.50 b	0.83 d	8.33 b
Baythroid	0.1	2.50 b	10.00 ab	16.67 b
Agri-Mek	0.04	0.00 b	4.17 cd	6.66 cd
Agri-Mek	0.08	3.33 b	5.00 bcd	2.50 d
Agri-Mek[b]	0.08	1.67 b	8.33 bc	12.50 bc
Alert[c]	0.2	2.50 b	3.33 cd	17.50 b
Untreated	--	10.00 a	15.00 a	28.33 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation. Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v except Agri-Mek that included NR-415 petroleum oil at 1.0 gal/acre. Applications containing Carzol included Neutralizer buffer at 0.125% v/v.

[b]Danitol was applied the first application, Agri-Mek the second and Dimethoate E267 the third.

[c]Danitol was applied the first application, Alert the second and Dimethoate E267 the third.

[d]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 9. Pyrethroid / Agri-Mek Test, 1996. Percentage of fruit infested with immature CT and TSM on lemons following application 3, May 15, 1996, and end of season fruit scarring ratings.

Third application		Mean percentage fruit infested with immature CT			Fruit scarring
Treatments[a]	Rate lbs(AI)/acre	May 17[d] 2 DAT (82.0 F)	May 20 5 DAT (81.5 F)	May 29 14 DAT (77.7 F)	Aug 16 Mature fruit
Carzol SP	1.38	0.00 c	0.83 d	4.17 c	1.65 b
Carzol + Baythroid	0.92 + 0.05	0.00 c	0.83 d	5.00 c	1.79 b
Baythroid	0.1	7.50 bc	11.67 c	16.67 b	1.73 b
Agri-Mek	0.04	0.83 c	5.00 d	13.33 bc	1.71 b
Agri-Mek	0.08	0.83 c	0.00 d	8.34 bc	1.75 b
Dimethoate E267[b]	1.34	10.83 bc	30.83 b	28.33 a	1.81 b
Dimethoate E267[c]	1.34	18.34 b	24.17 b	20.00 ab	1.61 b
Untreated	--	36.67 a	37.50 a	30.83 a	2.51 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation. Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v except Agri-Mek that included NR-415 petroleum oil at 1.0 gal/acre. Applications containing Carzol or Dimethoate 267 included Neutralizer buffer at 0.125% v/v.

[b]Danitol was applied the first application, Agri-Mek the second and Dimethoate E267 the third.

[c]Danitol was applied the first application, Alert the second and Dimethoate E267 the third.

[d]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 10. Experimentals, 1996. Percentage of fruit infested with immature CT on lemons following application 1, Apr 2, 1996.

First application		Mean percentage fruit infested with immature CT			
Treatments[a]	Rate lbs(AI)/acre	Apr 4 2 DAT[b] (67.3 F)	Apr 9 7 DAT (70.6 F)	Apr 15 13 DAT (70.1 F)	Apr 23 21 DAT (70.4 F)
Fipronil	0.15	0.83 d	0.83 b	2.50 a	2.50 c
Ni-25	0.075	0.83 d	1.67 b	1.67 a	6.67 bc
Alert	0.2	3.33 cd	1.67 b	1.67 a	5.83 bc
Alert	0.3	5.00 bcd	4.17 b	2.50 a	7.50 bc
Success	0.09	0.83 d	2.50 b	1.67 a	7.50 bc
Success	0.14	0.00 d	4.17 b	0.00 a	5.00 bc
Nexter	0.2	8.33 bc	4.17 b	0.83 a	7.50 bc
Nexter	0.3	10.84 a	4.17 b	2.50 a	8.33 bc
Nexter	0.4	4.17 bcd	3.33 b	0.83 a	10.00 ab
Carzol SP	1.38	2.50 cd	0.83 b	0.83 a	4.17 bc
Untreated	--	15.83 a	12.50 a	5.83 a	16.67 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation. Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v, Carzol also included Neutralizer buffer at 0.125% v/v.

[b]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 11. Experimentals, 1996. Percentage of fruit infested with immature CT on lemons following application 2, Apr 23, 1996.

Second application		Mean percentage fruit infested with immature CT		
Treatments[a]	Rate lbs(AI)/acre	Apr 25 2 DAT[c] (79.0 F)	Apr 29 6 DAT (79.3 F)	May 6 13 DAT (79.1 F)
Fipronil + Microthiol Special[b]	0.15 + 10.0	2.50 b	1.67 d	5.00 b
Ni-25	0.075	3.34 b	4.17 d	13.33 ab
Alert	0.2	0.00 b	5.83 cd	8.33 a
Alert	0.3	1.67 b	4.17 d	10.83 abc
Success	0.09	0.83 b	3.33 d	2.50 c
Success	0.14	0.00 b	3.33 d	2.50 c
Nexter	0.2	5.00 b	12.50 b	12.50 ab
Nexter	0.3	2.50 b	11.67 bc	13.34 ab
Nexter	0.4	2.50 b	12.50 b	15.00 a
Carzol SP	1.38	1.67 b	5.00 d	3.33 c
Untreated	--	15.00 a	21.67 a	16.67 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation. Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v, Carzol also included Neutralizer buffer at 0.125% v/v.

[b]Microthiol Special was included to help prevent flaring of mites.

[c]Days after treatment (DAT), and average daily temperature F, from time of most recent application.

Table 12. Experimentals, 1996. Percentage of fruit infested with immature CT on lemons following application 3, May 8, 1996, and end of season fruit scarring ratings.

Third application		Mean percentage fruit infested with immature CT				Fruit scarring
Treatments[a]	Rate lbs(AI)/acre	May 10 2 DAT[b] (78.3 F)	May 13 5 DAT (82.3 F)	May 20 12 DAT (82.2 F)	May 29 21 DAT (79.3 F)	Aug 19 Mature fruit
Fipronil	0.15	2.50 d	0.83 d	1.67 e	1.67 d	1.63 b
Ni-25	0.075	7.50 cd	13.33 bc	5.00 de	6.67 cd	1.81 b
Alert	0.2	2.50 d	2.50 cd	3.33 e	8.34 cd	1.63 b
Alert	0.3	3.33 d	1.67 d	6.67 de	12.50 b	1.76 b
Success	0.09	3.33 d	3.33 cd	1.67 e	1.67 d	1.69 b
Success	0.14	2.50 b	1.67 d	2.50 e	6.67 c	1.64 bc
Nexter	0.2	25.00 b	20.00 ab	17.50 bc	18.33 ab	1.71 b
Nexter	0.3	15.00 c	22.50 ab	15.83 cd	14.17 abc	1.65 b
Nexter	0.4	32.50 a	25.00 a	27.50 ab	22.50 a	1.64 b
Carzol SP	1.38	0.00 d	1.67 d	0.83 e	2.50 d	1.73 b
Untreated	--	37.50 a	27.50 a	30.83 a	21.67 ab	2.29 a

Means in a column followed by the same letter are not significantly different (F protected LSD $P < 0.05$) after square-root transformation (percentage infested fruit data only). Non-transformed data presented.

[a]All treatments were applied with Kinetic non-ionic surfactant at 0.1% v/v, Carzol also included Neutralizer buffer at 0.125% v/v.

[b]Days after treatment (DAT), and average daily temperature F, from time of most recent application.