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EFFICACY OF SPINOSAD AGAINST CHERRY FRUIT FLIES IN WASHINGTON STATE

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ABSTRACT

Laser is the first insecticide proposed for a new class of insect control products, the *Naturalytes*. Active ingredient of Laser called Spinosad is derived from the metabolites of the naturally occurring bacteria, *Saccharopolyspora spinosa*. Spinosad has been shown to be highly active on insects including species from the orders Lepidoptera, Diptera, Hymenoptera, Thysanoptera and a few Coleoptera. Spinosad may be used to control pests in both agricultural and horticultural environments, and also in greenhouses, golf courses, gardens, and around homes. Spinosad has been developed to provide rapid control of the pests with minimum disruption of beneficial insects and other non-target organisms.
Due to its very low effective use rate, safety to the environment, safety to the mammals, and safety to the beneficial insects, Spinosad was registered under the US EPA's reduced risk program. It was also awarded the *Presidential Green Chemistry Award* during 1999, which recognizes the unique contribution of Spinosad and also highlights Dow AgroSciences commitment to producing safer and more effective products for insect control.
Laser provides users with a unique package of very desirable features: highly effective on many pest species, low application rates resulting in low environmental load, safe for use with most beneficial insects, unique mode of action with no known cross-resistance, low mammalian toxicity, and low avian and fish toxicity.

IZVLEČEK

UČINKOVITOST SPINOSADA PROTI ČEŠNJEVI MUHI V WASHINGTONU

Laser je prvi insekticid iz nove skupine pripravkov, naturalitov. Aktivna snov v insekticidu laser je spinosad, ki jo pridobivamo iz metabolitov splošno razširjene vrste bakterije, *Saccharopolyspora spinosa*. Aktivna snov spinosad je zelo učinkovita proti žuželkam, vključno proti vrstam iz redov Lepidoptera, Diptera, Hymenoptera, Thysanoptera in nekaterim vrstam iz reda Coleoptera. Uporablja se za varstvo v kmetijstvu in hortikulturnih nasadih, v rastlinjakih, na igriščih za golf ter v vrtovih. Spinosad zagotavlja učinkovito varstvo proti škodljivcem, z najmanjšim vplivom na koristne in druge neciljne organizme. Ker je učinkovit pri zelo majhnih odmerkih in je varen za okolje, za sesalce ter koristne organizme, je bil spinosad registriran v US EPA programu z manjšim tveganjem (reduced risk program). Leta 1999 je bil nagrajen z Presidential Green Chemistry Award, kar potrjuje pomembnost te snovi in prizadevanja podjetja Dow AgroSciences za proizvodnjo varnejših in učinkovitejših sredstev za varstvo rastlin. Insekticid laser ima torej naslednje pomembne lastnosti: je zelo učinkovit proti številnim vrstam škodljivcev, uporabljamo ga v nizkih odmerkih, zaradi česar je obremenitev okolja manjša, je nenevaren za koristne organizme, ima poseben način delovanja, pri čemer ni znan pojav navzkrižne odpornosti ter ima nizko strupenost za sesalce, ptice in ribe.

1 INTRODUCTION

The Pacific Northwest states produce over half of the sweet cherries (*Prunus avium*) grown in the United States. As of 1998-1999, about 100,000 tons of this crop are produced yearly on about 25,000 acres, and significant increases are projected in both acreage and production. Cherry fruit fly (*Rhagoletis indifferens*) (CFF) is the primary insect pest of sweet cherries in the region. Quarantine agreements exist between the region and export markets to other countries, as well as to other states, particularly California. There is zero tolerance for CFF larvae in packed fruit. A single maggot detection can quarantine an entire packing house, resulting in a warehouse fumigation. This has forced growers into very intensive spray programs in an attempt to achieve perfect control. Growers begin spraying when first fly emergence is detected, and spray every week to 10 days, depending on product used, until harvest is completed. This program usually requires four to five applications by air-blast sprayer. Most programs rely heavily on azinphos-methyl and carbaryl sprays. Some regions rely heavily on aerial applications of malathion for season-long control, but this is considered a harvest-time supplemental spray on most of the acreage. All current products are under increased scrutiny, and regulatory restrictions due to the Food Protection Quality Act (FQPA). A new product is needed that has a high level of efficacy against dipteran pests, yet does not have the mammalian or environmental concerns of organophosphates or carbamates. Spinosad has very low mammalian and environmental toxicity, and is very active against many dipteran species. This research was done to determine if spinosad could provide the high levels of control needed against a pest with zero tolerance.

2 METHODS AND MATERIALS

Previous reports from northern California (personal communication - Dr. Robert A. vanSteenwyck, Univ. of California at Berkeley) were made of the effective control of walnut husk fly, *Rhagoletis completa*, by spinosad (Success* Naturalyte* insect control, NAF-315). This led to a preliminary spinosad probe study on CFF in Wenatchee, WA in 1997. Research trials in commercial orchards are difficult to conduct due to the quarantine nature of this pest. It is both difficult to find infestations due to the frequency of sprays in commercial orchards, and difficult to find cooperating growers who will risk their crops to unproven treatments or untreated controls. Thus, a non-commercial sweet cherry tree in a residential backyard was identified by the Chelan/Douglas County Agricultural Pest Board (CDCA) to be highly infested with CFF. Trees in this backyard had been highly infested in recent years and were serving as a source of infestation to neighboring commercial orchards. A single tree was treated with weekly applications of 2 ounces per 100 gallons of water. Applications were applied to drip or runoff to simulate a commercial volume of 400 gallons per acre. Zero larvae were found in 100 fruit sampled form this tree, despite high levels of adults and larvae from adjacent trees. This led to greatly expanded trials in the Wenatchee area in 1998 and 1999.

2.1 1998 Trial

The 1998 trial was carried out in a block of 16 mature highly infested sweet cherry trees in a residential property in East Wenatchee. This location had also been documented by the CDCA Pest Board to be highly infested by CFF over the past several seasons. A trap placed in the block in 1997 caught over 100 adults, which is an indication of serious infestation. Red sphere CFF traps (3.75 inch diameter) were baited with ammonium carbonate and placed throughout the test block. Trap catches should confirm presence of the pest and thus potential for fruit infestation. Trap catches can also indicate potential to control adults if differences are seen between trap locations relative to treatment locations. The seasonal CFF emergence model and actual adult catches for 1998 is shown in Figure 1.

Azinphos-methyl (Guthion 50WP) and carbaryl (Sevin XLR) are industry standards. Azinphos-methyl was applied for the first and third weekly sprays. Carbaryl was applied on the 2nd, 4th, 5th, and 6th weekly sprays. Spinosad (Success, NAF-315) was applied at either 7 day or 10 day intervals for either 6 or 4 total sprays before sampling., A light weight crop oil concentrate (JMS Stylet oil), was applied at 5 weekly intervals as an additional treatment option. Treatments are described in Table 1 below. All treatments began on 22 May 98. To reduce drift between trees, and minimize interference between treatments, treatments were blocked, instead of randomized, as shown in Figure 2. CFF can be a very mobile pest. Sampling, however, was randomized.

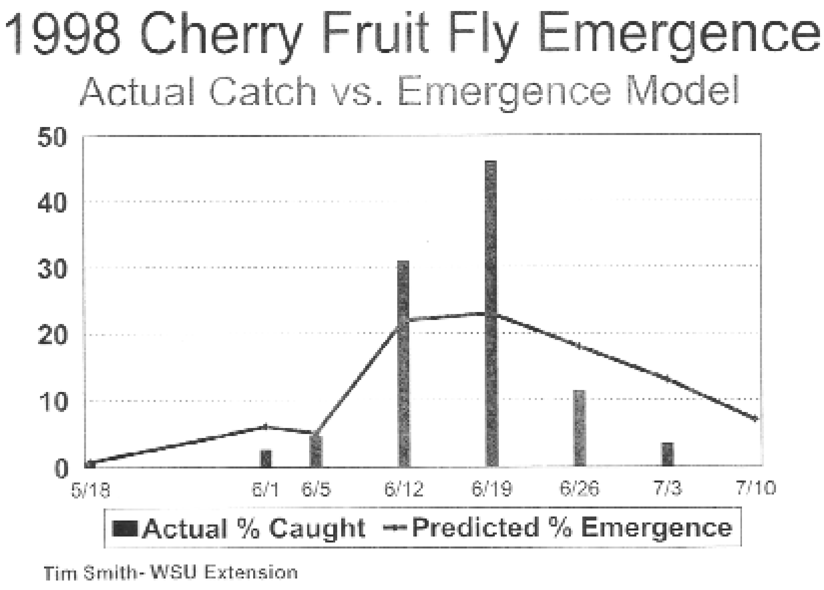

Figure 1: 1998 Cherry Fruit Fly Adult Trap Catch and Emergence Model.

Table 1: Treatment Description. East Wenatchee, WA. 1998.

Treatment No. & Name	**Rate**	**Application Interval**	**Appl. dates**
1. azinphos-methyl 50WP 1. carbaryl (Sevin XLR)	½ lb./100 gal. 16 fl.oz./100 gal.	1st and 3rd weeks 2nd, 4th, 5th weeks	5/22, 6/5 5/29, 6/12, 6/19
2. JMS Stylet Oil	1% v/v	5 times at 7 day intervals	Same as #1
3. spinosad 2SC	2 fl.oz./100 gal.	4 times at @ 10 day intervals	5/22, 6/1, 6/11, 6/19.
4. spinosad 2SC	2 fl.oz./100 gal.	5 times at 7 day intervals	Same as #1
5. untreated	-	-	-

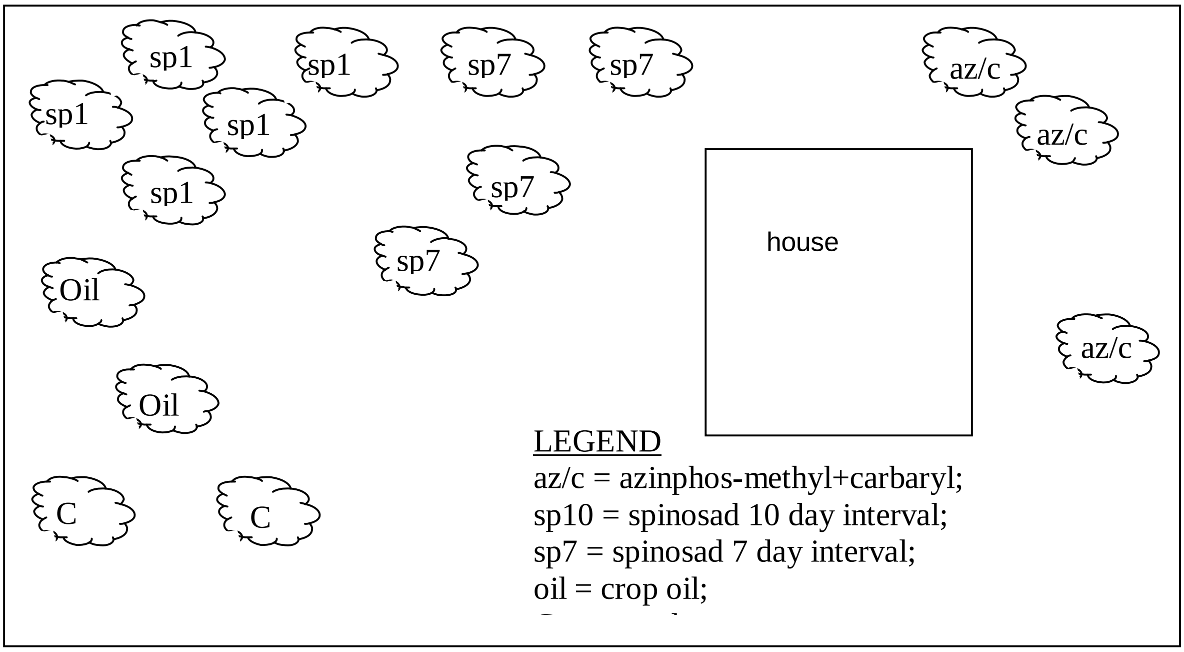

Figure 2: Plot map of 1998 residential trial

All products were applied with a high-pressure hand-gun, in a volume of water sufficient to fully wet the test tree foliage. Applications were applied to drip or runoff to simulate a commercial dilute spray volume of 400 gallons per acre. Sprays were initiated four days after the first CFF was trapped, and continued until the cherries were sampled for larval infestation. The sampling took place on June 26, about a week later than the usual harvest stage to assure maximum potential for infestation and larval development. After sampling, the entire block was treated with dimethoate on 02 Jul 98 to reduce the potential for 1999 CFF infestation at that location.

On June 26, 100 fruit samples were collected from each of four quadrants within each treatment, for a total of 400 fruit per treatment. The fruit was split and inspected, then crushed and mixed with a heavy solution of brown sugar and water to float the smaller larvae to the surface to complete the count.

2.2 1999 Trial

The 1999 trial was carried out in a block of 41 mature highly infested sweet cherry trees in a small residential orchard in Wenatchee, WA. This orchard, also identified by the CDCA Pest Board, was infested and had not been sprayed in recent years.

Eight 3.75 inch diameter red ball cherry fruit fly traps were placed randomly throughout the trial to assess the cherry fruit fly population during the pre-harvest treatment period. As in the 1998 trial, trap catches should confirm presence of the pest and thus potential for fruit infestation.

Table 2 below shows that all of the test block was infested, and for sufficient time to allow significant fruit infestation if adults were not controlled weekly. The seasonal CFF emergence model and actual adult catches for the region in 1999 is shown in Figure 3.

Table 2: 1999 CFF Catch by Week. Red sphere traps with ammonium carbonate.

Trap (Adjacent Trt.)	**June 3-10**	**June 10-17**	**June 17-24**	**June 24-30**	**TOTALS/ TRAP**
A (Trt. 6)	0	1	2	4	7
B (Trt. 6)	2	3	2	4	11
C (Check)	2	5	7	8	22
D (Trt. 1)	0	2	4	5	11
E (Trt. 3)	2	1	1	3	7
F (Trt. 2, 5)	1	4	8	8	21
G (Trt. 4)	2	1	4	3	10
H(Check)	3	8	6	7	24
TOTALS/WK	12	25	34	42	113

Treatments are listed in Table 3 below. Eight treatments were compared with four or more trees per treatment. Buffer trees sprayed with Provado (imidacloprid) at 4 oz/100 gallons separated the trees being evaluated. The standard of azinphos-methyl (Guthion 50WSP) and carbaryl (Sevin 50WP) was applied at 200 gallons per acre. Three rates of spinosad, 2, 4, and 8 fl.oz./A were compared at a spray volume of 100 gallons per acre. Spinosad at 8 fl.oz./A at a spray volume of 400 gallons per acre (2 fl.oz./100 gallons at 400 gallons/A) was also studied to determine if spray volume had an effect. Each of the above spinosad treatments contained 0.25% crop oil adjuvant. The 2 oz rate at 100 gallons/A was also compared with vs. without the 0.25% oil adjuvant.

Spinosad treatments started on June 3, 1999, three days after traps showed first fly emergence and were applied weekly (June 3, 10, 17, 24) for a total of four applications. For treatment 1, azinphos was applied twice (June 3 and 14) at an 11 day interval, then carbaryl was applied once on June 24. Materials were applied by “Solo” backpack airblast plot sprayer at various concentrations, with per-tree gallonage adjusted to approximate either 100 (concentrate) or 400 (dilute) gallons of water carrier per acre. The plot map is shown in Figure 4.

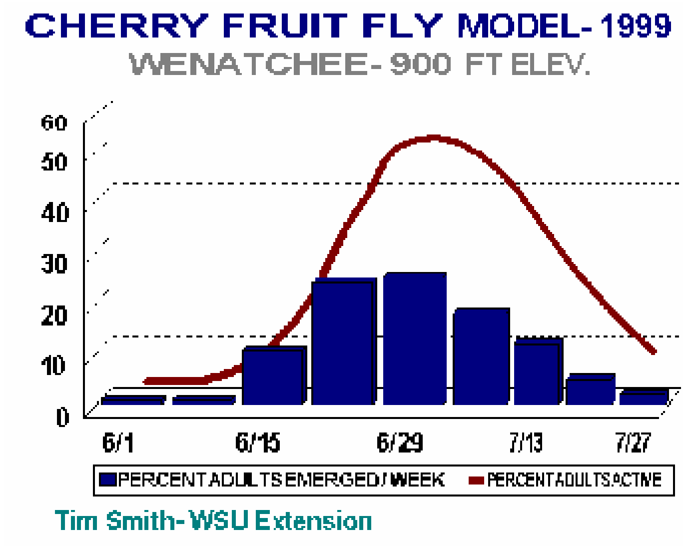

Figure 3: 1999 Cherry Fruit Fly Adult Trap Catch and Emergence Model.

Table 3: Treatment Description. Wenatchee, WA. 1999.

No.	Treatment	Rate / 100 Gallons	Gallons/Acre	Rate / Acre
1	Azinphos methyl **or** carbaryl (Sevin 50WP)	0.5 lb. 2 lb.	200	1 lb 4 lb
2	Spinosad + oil	2 oz. + 0.25%	400	8
3	Spinosad + oil	2 oz. + 0.25%	100	2
4	Spinosad + oil	4 oz. + 0.25%	100	4
5	Spinosad + oil	8 oz. + 0.25%	100	8
6	Spinosad	2 oz.	100	2
7	No Treatment	0	0	-
8	Sprayed Buffer Trees	-	-	-

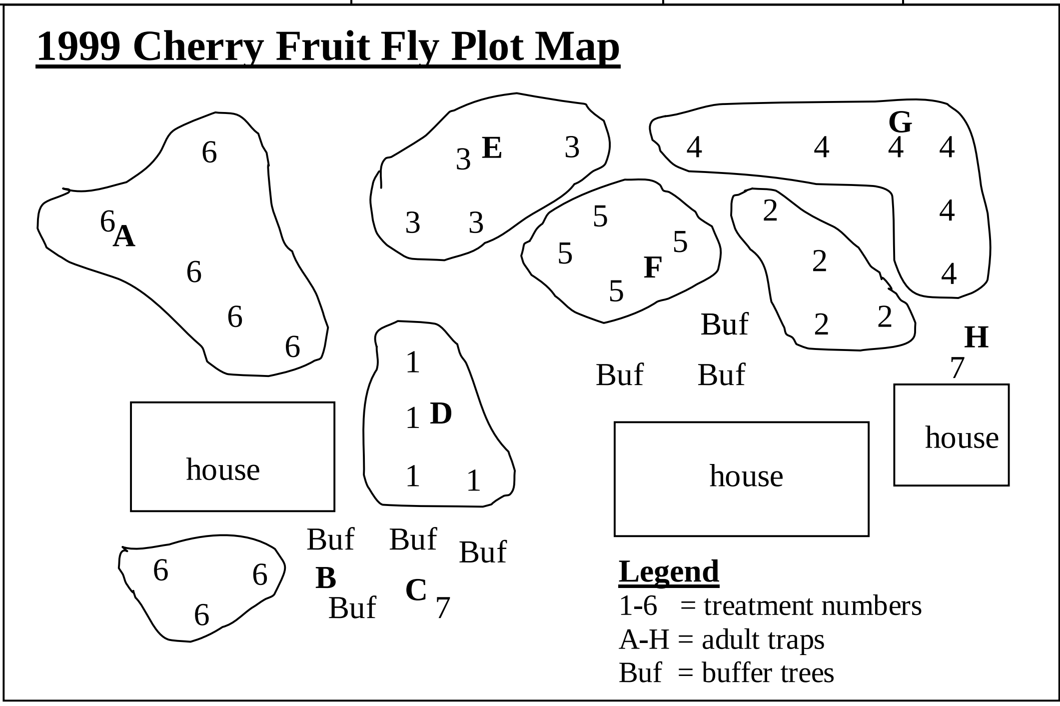

Figure 4: Plot map of 1999 residential orchard trial.

3 RESULTS AND DISCUSSION

3.1 1998 Trial

Table 4 below illustrates that CFF were present within the test block throughout the test period. Number of adult flies caught was similar across treatments, but increased sharply at the 12 Jun sample date in the untreated trees of the trial. This corresponds with the increase seen in the CFF adult emergence model and with adult catches in the region as seen in Figure 1. However, adult trap catches were much lower in the treated trees (Figure 5). This indicates that spinosad applications at 7 or 10 day intervals might be able to reduce numbers of adult flies in treated orchards.

Table 4: 1998 Cherry Fruit Fly Catch by Week. Red sphere traps with ammonium carbonate

Trap No. & Treatment	5/18	6/1	6/5	6/12	6/19	6/26	7/3	Total
1. Azinphos / Sevin	-	0	1	5	2	1	0	**9**
2. Success-7 Day	-	0	0	1	1	1	0	**3**
3. Success-10 Day	-	0	2	3	3	2	0	**10**
4. Stylet Oil - 7 Day	-	1	2	0	1	0	0	**4**
5. Untr. Check	-	1	0	8	17	4	2	**32**
6. Untr. Check	-	-	-	15	27	5	2	**49**
7. Pest Board Trap	1	1	0	3	2	0	0	**7**
Weekly Total	1	3	5	35	53	13	4	**114**
Running Total	1	4	9	44	97	110	114	**114**

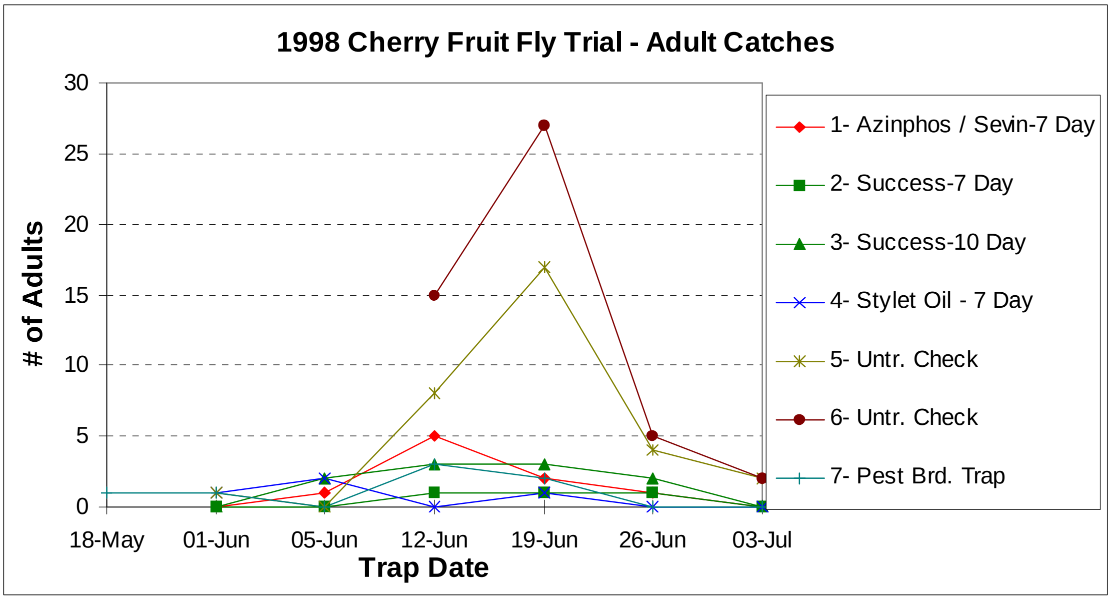

Figure 5: 1998 Adult CFF Trap Catches. Red sphere traps with ammonium carbonate.

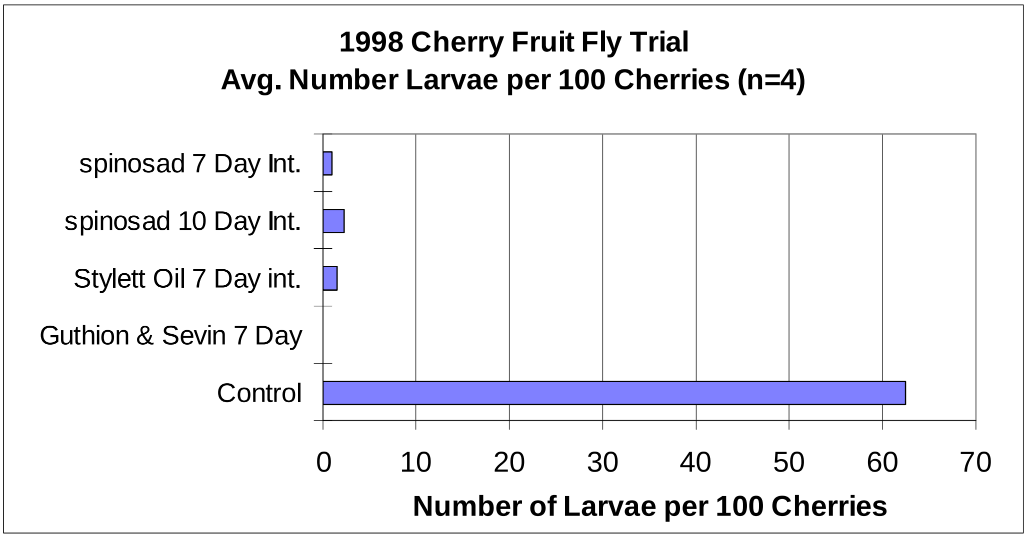

Figure 6: Avg. Number of CFF larvae per 100 cherries. 1998. (n=4)

Final counts of CFF larvae showed very high infestation rate of 62.5% in the untreated trees (Table 5, Figure 6). The Guthion & Sevin treatment had zero larvae. The two spinosad and the single oil treatments all performed very well in this trial, with 1.0-2.25 larvae per 100 fruit. The highest number of larvae in the spinosad treatments was 6 in one replicate of the 10 day interval treatment. This would be unacceptable for a zero tolerance quarantine pest. It is possible that the infestation of the spinosad-treated fruit occurred when mature, bred females wandered from the unsprayed trees into the spinosad treated areas. The population pressure, as indicated in the untreated, was extraordinarily high. These high levels would not be seen in a commercial orchard. Due to the excellent activity of spinosad under very high insect pressure, it can be concluded that spinosad could be a legitimate tool in CFF control programs, although spinosad at 7 day intervals performed better than at 10 day intervals. Although the oil alone showed very low numbers of larvae, growers would be hesitant to use rates as high as 1%. The 1% oil completely removed the glossy sheen expected of cherries. No adverse effects to fruit or foliage were noted from spinosad or Guthion/Sevin treatments. Spinosad with 0.25% oil had no adverse effect on fruit finish.

Table 5: 1998 Counts of CFF Larvae per 100 Cherries

Treatment	Rep 1	Rep 2	Rep 3	Rep 4	Avg/Rep
1. Guthion & Sevin	0	0	0	0	**0**
2. Stylett Oil, 7 Day int.	4	1	0	1	**1.5**
3. Spinosad, 10 Day Int.	0	0	3	6	**2.25**
4. Spinosad, 7 Day Int.	1	0	1	2	**1.0**
5. No Treatment	71	73	51	55	**62.5**

3.2 1999 Trial

Table 2 showed that adult CFF were present throughout the residential orchard. Numbers of adults trapped increased from the beginning to the end of June. The untreated samples had a high infestation rate of 21.75%, confirming the pressure in the orchard (Table 6).

Despite the high population pressure, no larvae were detected in any of the treatments. No differences were seen between spinosad at 2 fl.oz./A with or without an oil adjuvant. No differences were seen between spinosad at 8 fl.oz./A at 100 gallon/A or 400 gallon/A spray volume. No rate response was seen from 2 fl.oz./A to 4 fl.oz./A, to 8 fl.oz./A. Spinosad demonstrated excellent activity of CFF at levels needed for a zero tolerance quarantine pest. No adverse effects from any of the treatments were noted on the tree foliage or the cherry fruit.

Table 6: 1999 Counts of CFF Larvae per 100 Cherries

Treatment	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Avg./Rep**
1. azinphos-methyl, carbaryl	0	0	0	0	0
2. spinosad 2 oz/100, 400 gpa plus 0.25% oil	0	0	0	0	0
3. spinosad 2 oz/100, 100 gpa plus 0.25% oil	0	0	0	0	0
4. spinosad 4 oz/100, 100 gpa plus 0.25% oil	0	0	0	0	0
5. spinosad 8 oz/100, 100 gpa plus 0.25% oil	0	0	0	0	0
6. spinosad 2 oz/100, 100 gpa	0	0	0	0	0
7. untreated control	12	23	16	36	21.75

4 CONCLUSIONS

The standard program of azinphos-methyl and carbaryl was the only treatment that provided zero infestations in both trials. Populations in 1998 and 1999 were much higher than would be found in commercial orchards. Nevertheless, spinosad remained highly effective. Under the sort of insect pressure found in commercial blocks, it could be expected to provide very good control of cherry fruit fly, as well as supplement control of leaf rollers and leaf miners, two secondary sweet cherry pests.