

Reduced Application Rates of Provado for Management of Leafhoppers and Aphids on Apple

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Two leafhopper species, the white apple leafhopper (WALH), *Typhlocyba pomaria* McAtee and the potato leafhopper (PLH) *Empoasca fabae* Harris, comprise a complex that annually damages apple foliage in New York State. In the Hudson Valley region, moreover, the rose leafhopper (RLH), *Edwardsiana rosae* (L.) is an annual pest, due in large measure to the widespread occurrence of its alternate host, multiflora rose. Damage to apple foliage by the mesophyll-feeding hoppers (WALH and RLH) appears as stippling or leaf chlorosis. The migratory PLH is a terminal-feeder that injects a salivary toxin while feeding, producing symptoms ranging from chlorosis to the typical "hopper burn," resulting in reduced growth rate of terminals. Accumulated excrement from the leafhopper complex reduces the marketability of fresh market fruit, while moderate to high adult presence at harvest causes considerable annoyance to harvesters.

Although three species of terminal-feeding aphids attack New York apple, the green apple aphid (GAA), *Aphis pomi* De Geer, is generally considered as the pest of greatest significance. Feeding on new growth by GAA nymphs causes stunted and misshapen leaves. Because aphids produce honeydew, high populations feeding in proximity to fruit clusters can cause cosmetic damage due to development of the sooty mold fungus on this sugary exudate. Less commonly, they cause blemishes by feeding directly on developing fruit.

The current treatment threshold for combined WALH and RLH is >1.0

nymph per leaf for the first and subsequent generations. Because PLH nymphs and adults affect only new-growth foliage, management in established bearing orchards is generally not recommended. In new plantings, however, where rapid growth is essential, insecticide treatment is often advisable. A treatment threshold for GAA has not been established. This pest generally has a narrow window of occurrence during spring. Populations will often be dramatically affected by a duo of natural enemies (larvae of *Cecidomyiidae* and *Coccinellidae*) if detrimental insecticides are withheld. Nonetheless, if populations remain excessive for an extended time period, many growers will apply pesticidal control measures.

Provado 1.6F insecticide is generally recognized for its high degree of efficacy against sucking insects, particularly leafhoppers and aphids. Because this insecticide is costly relative to older standards, we performed field trials using applications of reduced rates and various application timings to examine efficacy against leafhoppers and aphids, and to assess the effects on aphid natural enemies.

Leafhopper Nymphs and Adults, 2000

During September, treatments comprising full-label rate (8.0 oz/acre) and one-quarter label rate (2.0 oz/acre) of Provado were compared to full-label rate (48.0 oz/acre) and one-quarter label rate (12.0 oz/acre) of Sevin XLR. Efficacy against WALH and RLH nymphs (number/leaf) and adults (numbers/3 min. collected by a vacuum sampler,

Provado insecticide is generally recognized for its high degree of efficacy against sucking insects, particularly leafhoppers and aphids but it is costly relative to older standards. This research shows that with this highly effective insecticide, reduced rate application strategies can be employed to economically maintain these two pest complexes at non-damaging levels.

Figure 1) was determined at 2d, 4d and 10d post treatment, respectively. Results showed very good efficacy against nymphs from reduced rates of both insecticides (Table 1). At 4d post treatment, significant reductions in adult numbers were obtained by one-quarter label rates of both insecticides; at 10d post treatment, however, all Provado treatments were superior to Sevin XLR. The enhanced persistence of Provado is logical, given that the neonicotinoid active ingredient penetrates, and is stored in, the leaf (translaminar), whereas Sevin XLR has no similar properties. Prior to the registration of Provado, various formulations of Sevin were used extensively in New York to manage leafhoppers.

Our results show that reduced rates of Provado are effective against both



Figure 1. Vacuum apparatus used to collect leafhopper adults from apple trees.



Figure 2. Damage from nymphs of white apple and rose leafhopper.

motile stages of leafhoppers, significantly more so than the older standard.

Leafhopper Nymphs, 2001

Having demonstrated that greatly reduced rates were effective, we sought to examine the cost effectiveness of various programs. Treatment scenarios using full, one-quarter and a combination of full and one-quarter label rates of Provado were compared during mid-season (3rd to 5th cover). During this period, indigenous WALH and RLH, and migratory PLH are usually present in Hudson Valley apple orchards. In general, 3rd cover applications impact immigrating adult PLH, 4th cover applications coincide with nymphal emergence of all three species, while 5th cover applications affect early instar nymphs of all species. Efficacy was assessed, one day after the final application, by counting numbers of nymphs/leaf, and by observing foliar symptoms of PLH damage. The cost of each spray program was estimated based on a local distributor quote (\$4.00 per oz. of formulation). All rates and application timings provided very good control of WALH and RLH (Table 2). Against high

| Treatment | Amt./ acre | No. nymphs/25 leaves | | No. adults/3 min. (percent reduction) ² | |
|----------------|---------------|----------------------|---------------|--|-----------------|
| | | 2d post treat. | | 4d post treat. | 10d post treat. |
| Provado 1.6F | 8.0 oz | 0.0 a | 6.1 ab(93.7) | 2.9 a (97.5) | |
| Provado 1.6F | 4.0 oz | 0.0 a | 7.3 ab (95.0) | 2.9 a (97.6) | |
| Sevin XLR plus | 48.0 oz | 0.6 a | 3.8 a (96.1) | 12.5 b (87.1) | |
| Sevin XLR plus | 12.0 oz | 0.8 a | 9.9 b (87.8) | 23.5 bc (71.2) | |
| Untreated | - | 28.6 b | 78.6 c (4.3) | 77.2 c (6.1) | |

Means followed by the same letter are not significantly different (P=0.05; Fisher's protected LSD).

¹White apple and rose leafhopper (>95 percent rose leafhopper).

²Adults collected by vacuum sampler. Reduction based on precounts taken 17 Sept.

populations of PLH nymphs, multiple applications generally provided superior control regardless of rate - PLH continually reinfest new leaves not exposed to residues from previous applications. Assessment of foliar damage (chlorosis and curled leaves) by PLH revealed that multiple applications of reduced rates were generally effective in the reduction of both symptoms, particularly curled leaves. By comparisons of each program's economics, it is apparent that effective management of leafhoppers can be achieved at significantly reduced costs. Because established apple trees can tolerate a good deal of damage from the indirect feeding of leafhoppers, multiple applications of Provado at one-quarter label rate is a logical program.

Green Apple Aphid and Predators, 2002

Because Provado is often used during early season to manage GAA infestations, an experiment was designed to examine the effects of reduced rates against this pest and two of its most important natural enemies. Similar to leafhopper studies, full, one-half, one-



Figure 3. Apple terminal infested by green apple aphids.

quarter, and one-eighth label rates of Provado were applied once during mid-summer. Thirty aphid-infested terminals/replicate were tagged for pre treatment counts and subsequent evaluation. Post-treatment aphid counts were made at 3d, 7d and 23d. Aphid numbers per terminal

| Treatment | Amt./ acre | Timing ¹ (no. apps.) | No./leaf | | Percentage shoot lvs. | | |
|------------------|---------------|------------------------------------|---------------------------|------------------|----------------------------------|-------------------------------|----------------------------|
| | | | WALH, RLH ² | PLH ² | chlorosis by PLH ² | curled by PLH ² | Cost/ acre ³ |
| Provado 1.6F | 8.0 oz | 3C (1) | <0.1 | 13.0 | 66.0 | 43.0 | \$32.00 |
| Provado 1.6F | 8.0 oz | 3, 4C (2) | 0.0 | 1.6 | 19.0 | 4.0 | \$64.00 |
| Provado 1.6F | 8.0 oz | 3C (1) | | | | | |
| Provado 1.6F | 2.0 oz | 4,5C (2) | 0.0 | 0.2 | 56.0 | 1.0 | \$48.00 |
| Provado 1.6F | 2.0 oz | 3-5C (3) | 0.0 | 0.7 | 37.0 | 6.0 | \$24.00 |
| Untreated | - | - | 5.1 | 11.0 | 97.0 | 77.5 | |

¹Third cover, fourth cover, etc.

²White apple leafhopper(WALH), rose leafhopper(RLH) and potato leafhopper(PLH).

³Based on estimated cost of \$4.00 per ounce of formulation and 400 gal./acre.

TABLE 3

Efficacy of reduced rates of Provado against green apple aphid, 2002.

| Treat. | Amt./ acre | 3d post treat. | | 7d post treat. | | 23d post treat. | |
|--------------|---------------|------------------------------|-------------------------------|-----------------|------------------|-----------------|------------------|
| | | 27 June | | 1 July | | 17 July | |
| | | Aphid rating ¹ | Percent redn. ² | Aphid rating | Percent redn. | Aphid rating | Percent redn. |
| Provado 1.6F | 8.0 oz | 0.70 a | 76.7 | 0.14 a | 95.3 | 0.06 a | 97.9 |
| Provado 1.6F | 4.0 oz | 1.05 b | 65.0 | 0.37 b | 87.7 | 0.05 a | 98.4 |
| Provado 1.6F | 2.0 oz | 1.38 c | 54.0 | 0.53 b | 82.3 | 0.20 a | 93.3 |
| Provado 1.6F | 1.0 oz | 1.49 c | 50.3 | 0.89 c | 70.3 | 0.08 a | 97.5 |
| Untreated | - | 2.85 c | 5.0 | 2.71 d | 9.7 | 0.15 a | 95.0 |

Means followed by the same letter are not significantly different (P=0.05; Fisher's protected LSD).

¹Rating (0 – 3) of aphid numbers/terminal; see text for details.

²Based on precounts taken 24 June.

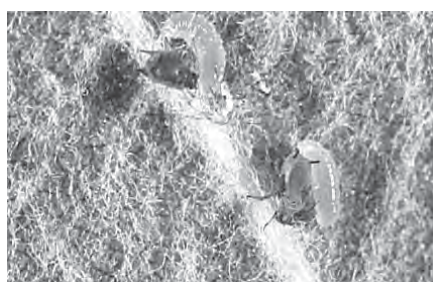


Figure 4. Natural enemies of apple aphids.

were estimated by a rating where: 0 = no aphids; 1 = 1-10 aphids/leaf; 2 = 11-100 aphids/leaf; and 3 = >100 aphids/leaf. Treatment effects on predators were assessed 7d post treatment by counting the number of larvae/5 apical terminal leaves.

At the 3d and 7d assessment dates, GAA reductions followed a dose-response relationship (i.e., full rate > one-half rate, etc.) (Table 4). At 7d, all treatment rates reduced GAA numbers by at least 70 percent. Aphid numbers in all treatments, including untreated, decreased >90 percent 27d after application. In most years, as July wanes, aphid populations naturally decline due to lack of succulent tissue as terminal buds set, and/or because of natural enemies. The results indicate that decreasing rates of Provado provided decreasing efficacy against GAA; however, all but the one-eighth

TABLE 4

Efficacy of reduced rates of Provado against two key aphid predators, 2002.

| Treatment | Amt/ acre | 7d post treat. (1 July) ¹ | | Percent reduction ² | |
|-----------|--------------|--------------------------------------|-------------------------------|--------------------------------|-------------------------------|
| | | Cocc. ³ larvae | Cecid. ³ larvae | Cocc. ³ larvae | Cecid. ³ larvae |
| | | Provado | 8.0 oz | 0.01 a | 0.03 a |
| Provado | 4.0 oz | 0.02 a | 0.04 a | 84.3 | 93.8 |
| Provado | 2.0 oz | 0.07 ab | 0.04 a | 87.8 | 93.2 |
| Provado | 1.0 oz | 0.20 b | 0.19 b | ↑ 329.2 | ↑ 53.6 |
| Untreated | - | 1.19 c | 0.21 b | ↑ 487.2 | ↑ 22.0 |

Means followed by the same letter are not significantly different (P=0.05; Fisher's protected LSD).

¹Average number of larvae/aphid infested terminal.

²Based on precounts taken 24 June.

³Cocc. = Coccinellidae (Coleoptera); Cecid. = Cecidomyiidae (Diptera); ↑ = population increase.

label rate provided considerable, and probably acceptable, efficacy.

A single application of Provado was generally detrimental to larvae of *Coccinellidae* and *Cecidomyiidae* (aphid predators) (Table 4). All treatments between full and one-quarter label rates significantly reduced numbers of both predators. The one-eighth label rate however, allowed both predator species to increase dramatically at 7d after application. Such increases may have contributed to the 70 percent reduction in GAA populations provided by this treatment (Table 3). These results suggest that the one-eighth label rate provides adequate suppression of aphids, while not affecting predators.

Producers would need to decide the degree of control desired for a particular situation. If management or suppression below some marginal level of damage is desired, reduced rates of Provado could provide a cost effective program against leafhoppers and aphids. Expenditures could be reduced to an even greater degree if reduced rates of Provado were tank mixed with other pest control treatments during regular cover spray periods.

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