Seasonal Abundance and Control of the Rhododendron Gall Midge, *Clinodiplosis rhododendri* (Felt), in Container Grown *Rhododendron catawbiense* Michaux[1]

James L. Hanula[2]
Department of Entomology
The Connecticut Agricultural Experiment Station
P.O. Box 1106
New Haven, Connecticut 06504

Abstract

The seasonal abundance and control of the rhododendron gall midge, *Clinodiplosis rhododendri* (Felt), were investigated on container grown *Rhododendron catawbiense* Michaux. Most of the midge population studied completed 3 generations, and at least some completed 4–5 generations during the growing season (May–October 1989). Adults that developed from overwintered larvae began emerging on May 14, 1989. Three of the peaks in adult emergence coincided with bud break during the three growth flushes observed in the nursery. Only 20% of the buds were infested during the first growth flush, while 95% were infested during the second and third growth flushes. The low level of infestation during the early growth period provides an opportunity to detect an infestation before extensive damage occurs.

Five insecticides were tested as soil drenches to control overwintering larvae. All five were equally effective and reduced the number of emerging adults by 95–100%. Further tests with Dursban 2E (chlorpyrifos) showed that soil surface applications were also effective, and that the timing of irrigation did not affect control. Soil drenches with two additional materials, Safer's insecticidal soap and Pratt horticultural oil, were not effective.

Index words: Rhododendron gall midge, rhododendron, insect control

Insecticides used in this study: Diazinon 4E (diazinon), O, O-diethyl O-(2-isopropyl-6-methyl-4-pyrimidinyl); Dursban 2E (chlorpyrifos), O, O-diethyl O-(3,5,6-trichloro-2-pyridinyl) phosphorothioate; Furadan 4F (carbofuran), 2-3-Dihydro-2,3-dimethyl-7-benzofuranyl methylcarbamate; Resmethrin 26% EC (resmethrin), (5-benzenyl-3-furyl) methyl-2,2-dimethyl-3-(2-methyl-propenyl)cyclopropanecarboxylate; Triumph 4E (isazofos), O-(5-chloro-1-[methylethyl]-1H-1,2,4-triazol-3-yl) O, O-diethyl phosphorothioate.

Significance to the Nursery Industry

The rhododendron gall midge attacks new buds and leaves causing leaf curling and distortion. Extensive damage from this insect was observed in several nurseries in Connecticut. This study demonstrates that insecticides applied to the soil as drenches were effective for the control of overwintering larvae in container grown *Rhododendron catawbiense*. Further testing with Dursban 2E showed that soil surface applications were effective regardless of the timing of irrigation, and that effective control could be achieved on a large scale. Soil surface applications are preferable to foliar sprays, because they can be applied over a longer period of time. Therefore, they provide greater flexibility in scheduling and improved control over the previously used foliar applications.

Studies of seasonal abundance showed that the midge completed at least 3 generations during the 1989 growing season in Connecticut. However, only a small proportion (20%) of the buds were infested during the first growth flush, suggesting that early detection and treatment can prevent extensive damage during the later growth periods. Container nurseries provided optimal conditions for the development of this pest.

[1]Received for publication August 2, 1990; in revised form January 10, 1991.

[2]Assistant Entomologist.

Introduction

The rhododendron gall midge, *Clinodiplosis rhododendri* (Felt), feeds on a number of *Rhododendron* spp. from North Carolina to Massachusetts causing leaf discoloration and deformation (2, 3). Although originally described from Long Island, N.Y., the midge has not been a common pest in Connecticut until recently, when it began causing extensive damage to container grown *Rhododendron catawbiense* Michaux varieties and was frequently reported in landscape plantings.

The midge overwinters in the soil as larvae. Adults emerge in the spring and lay eggs on expanding buds and leaves (2). In the past, applications of insecticide to control this pest were timed to coincide with bud break. This method was effective but presented several problems. First, the early spring growth flush occurs at the same time as the spring shipping season when few workers are available to apply insecticides and when persons are handling the plants extensively, increasing their exposure to pesticide residues. Timed applications are also difficult for landscape managers who must service many clients in a short time if foliar applications are to be effective. However, Valley (3) suggested that applications to the soil, similar to control measures tested by Smith and Webb (1) for the rose midge, *Dasineura rhodophaga* (Coquillett), might be effective.

Studies were initiated in 1989 to determine the seasonal abundance of rhododendron gall midge on container grown *R. catawbiense* varieties, and to develop an effective control strategy.

Materials and Methods

Insecticide trials. In the first trial, 5 insecticides were tested at 2 rates each as soil drenches for control of overwintering larvae. Heavily damaged *R. catawbiense* 'Roseum elegans' plants grown in 3.8 l (1 gal) black plastic containers were transferred to a heated greenhouse on January 27, 1989. The plants were grown in a potting medium consisting of humus, peat and perlite (1:1:1). Treatments were applied as a drench by pouring 500 ml (2 pint) over the soil surface of each container. The insecticides were Diazinon 4E (diazinon) and Triumph 4E (isazofos) at 1.8 and 3.6 g ai/100 l (0.015 and 0.03 lb ai/100 gal); Furadan 4F (carbofuran) and Resmethrin 26% EC (resmethrin) at 3.6 and 7.2 g ai/100 l (0.03 and 0.06 lb ai/100 gal); and Dursban 2E (chlorpyrifos) at 59.7 and 119.4 g ai/100 l (0.5 and 1 lb ai/100 gal).

Following treatment, the plant stems were severed at the soil line, and an adult emergence trap was placed over the top of each container. Emergence traps consisted of a truncated cone (16.5 cm (6.4 in) bottom diameter and 8 cm (3.1 in) top diameter) constructed from white, 6 ply cardboard. A 10 cm (4 in) diameter polypropylene funnel was inverted and pushed up inside the cone until the funnel lip formed a tight seal with the cardboard. Funnels were held in place with gray duct tape. A 1.5 cm (0.6 in) diameter hole was cut into the lid of a 30 ml (1 oz) clear plastic portion cup, which was inverted over the spout of each funnel. Emerging adults trapped in the cups were counted to measure treatment effects. Each treatment was replicated 10 times.

A second trial was conducted with Dursban 2E to determine if lower volume applications to the soil surface were effective and if dilution of the insecticide by irrigation would affect control. Two groups of plants were treated on April 5. One group received irrigation to runoff 1 hr before the insecticide was applied, and the second group received an equal amount of water 1 hr after treatment. In preliminary trials, approximately 40 ml (1.3 oz) of solution were required to thoroughly cover the soil surface of a 3.8 l container. Applications of 40 or 80 ml of Dursban 2E at a rate of 119.4 g ai/100 l (1 lb ai/100 gal) were made to the soil surface with a hand-held sprayer. A third treatment of 40 ml of 238.8 g ai/100 l (2 lb ai/100 gal) was included in each group. Adult emergence was monitored as previously described to determine treatment efficacy.

A third trial was conducted (April 1989) with Dursban 2E to evaluate its efficacy in a large scale application in Clinton, Connecticut. Initial tests were conducted with water to select an effective spray nozzle and pressure. A Dramm low pressure sprinkler nozzle at 50–60 psi provided the best penetration of insecticide solution through the dense foliage to the soil surface in the shortest period. Small plastic cups, placed on the soil surface before the spray trial, were used to calibrate the operators speed so that each container received approximately 40 ml of insecticide solution. All areas that contained potted *R. catawbiense* plants damaged the previous year were treated. The soil of areas where plants were stored outside of the greenhouses was also treated. Treatment efficacy was evaluated by comparing the number of infested buds in treated and untreated areas. An uncovered plot of 1000 'Roseum elegans' and 'Nova zembla' rhododendrons were set aside as checks and for studies on the seasonal biology.

Safer's insecticidal soap and Pratt horticultural oil were tested as alternatives to conventional insecticide for midge control. Soil surface applications were made with a hand-held sprayer at rates of 40 and 80 ml (1.3 and 2.6 oz) per container of 1:50 and 1:33 dilutions of horticultural oil, and 19.7 ml/l (2.5 oz/gal) of insecticidal soap. A treatment of 40 ml of Dursban 2E at 119.4 g ai/100 l (1 lb ai/100 gal) was also included for comparison. Plants were treated on November 11, 1989 and left uncovered outdoors until January 16, 1990, when they were placed in the greenhouse and monitored for adult emergence. Treatments were replicated ten times.

Midge seasonal abundance. A plot of 1000 unsprayed *R. catawbiense* plants was established within a large container nursery in Clinton, Connecticut. The plants were grown under the same conditions as the main nursery, but without pesticides and pruning.

Fifteen to 25 branch samples were collected weekly from May 4 to October 5, 1989 to monitor immature stages of the rhododendron gall midge. Samples consisted of mature leaves from the previous growth flush and expanding buds or leaves. Samples were refrigerated and examined within 24 hours. Each leaf was measured and rated according to damage on a scale of 0–5: 0 = no damage; 1 = normal shape but with a few chlorotic feeding spots; 2 = normal shape but with numerous feeding spots; 3 = normal size but with one side curled under; 4 = stunted growth with one side curled and feeding damage on the other; 5 = stunted with both sides curled under. Leaves were then examined for eggs and larvae. Larvae were removed, preserved in 70% ethyl alcohol, and examined later to determine instars. Preserved larvae were mounted on microscope slides in Hoyer's solution to clear them so larval characteristics could be observed. Instars were separated by using the following characteristics: first instars have only two caudal spiracles, second instars have spiracles on abdominal segments 1–8, and third instars have a spatula on the venter of the prothoracic segment (R.J. Gagné, personal communication).

Adult emergence was monitored weekly with the traps previously described for evaluating insecticide trials. Fifteen plants were selected at 2–3 week intervals and fitted with emergence traps. The cardboard portion of the traps were covered with a clear plastic bag to prevent damage from the overhead irrigation. Traps were monitored until no adults were collected from them for three weeks.

Results and Discussion

Insecticide trials. Overwintering larvae of the rhododendron gall midge were easily controlled with soil drenches. All insecticides and rates tested were equally effective for this purpose and provided almost 100% control (Table 1). Dursban was selected for further testing because the nursery where the tests were conducted was in an environmentally sensitive location, and Dursban was the least likely to move off site. However, from the results in Table 1 it is apparent that most of the other insecticides tested would have performed equally well.

Timing of irrigation and the volume or concentration of Dursban had no effect on the level of control of overwintering larvae (Table 2). Despite dilution by irrigation, all

Table 1. **Effects of insecticide soil drenches for control of overwintering rhododendron gall midge larvae, *Clinodiplosis rhododendri*, in container grown *R. catawbiense* ('Roseum elegans').**

Insecticide[z]	Rate		Midges/container[y]
	g ai/100L	lb ai/100 gal	
control	—	—	14.6 a
Diazinon 4E	1.8	0.015	0.6 b
Diazinon 4E	3.6	0.03	0.1 b
Resmethrin 26% EC	3.6	0.03	0.1 b
Resmethrin 26% EC	7.2	0.06	0.3 b
Dursban 2E	59.7	0.50	0.3 b
Dursban 2E	119.4	1.00	0.0 b
Furadan 4F	3.6	0.03	0.0 b
Furadan 4F	7.2	0.06	0.0 b
Triumph 4E	1.8	0.015	0.0 b
Triumph 4E	3.6	0.03	0.0 b

[z]Applied February 2 and evaluated March 6, 1989.

[y]Mean separation within columns by Duncan's multiple range test, 5% level.

treatments provide 100% control. These results suggest that lower concentrations of Dursban may provide control.

Dursban also performed well in the large scale application. Extensive scouting of the treated area produced no infested buds during the first growth flush, while 20% of the buds in the treated plot were infested. Some reinfestation did occur during the second growth flush in July. However, areas of infestation were only found in close proximity to newly propagated plants and the control plot. These new areas of infestation were the result of poor control in a block of large, field grown *R. catawbiense* used to provide cuttings. No new infestations were detected throughout the year in other areas, suggesting that one application was sufficient to provide season long control.

Horticultural oil and insecticidal soap did not significantly reduce the numbers of emerging rhododendron gall midge adults, regardless of concentration or volume of material used. An average of 11.1 (SE = 3.45) and 4.5 (SE = 1.78) midges emerged from containers treated with 80 ml of horticultural oil (1:33 dilution) and insecticidal soap, respectively. An average of 4.1 (SE = 1.55) midges emerged from the untreated plants, while Dursban treated plants averaged 1.0 (SE = 0.49) midge/plant.

Seasonal abundance. The rhododendron gall midge had at least 3 generations, and possibly 5 or more, per year on container grown *R. catawbiense* varieties (Fig. 1). Overwintered midges began emerging as adults from container soil on May 14. Peak adult emergence of the overwintered

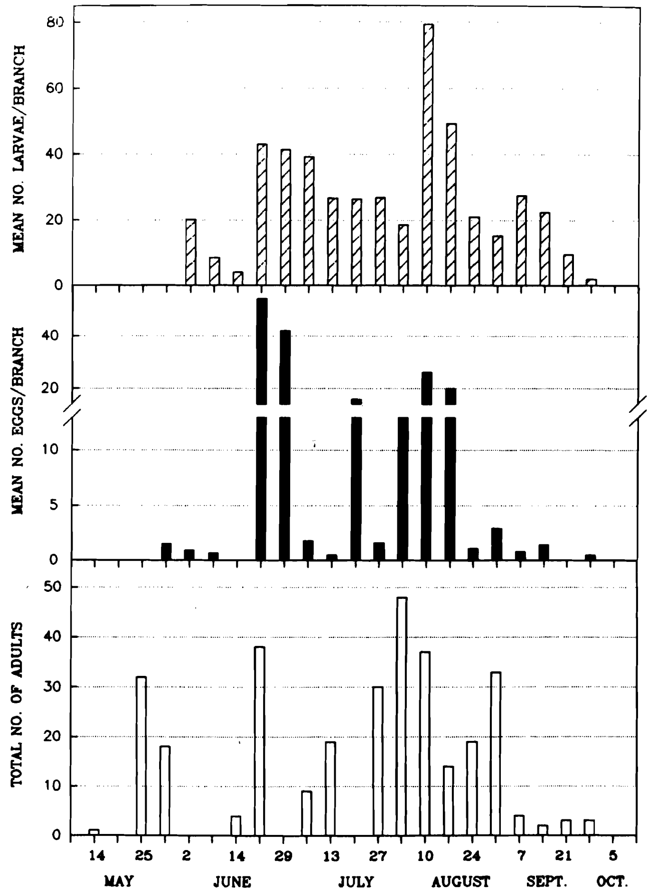

Fig. 1. **Seasonal abundance of rhododendron gall midge eggs, larvae and adults on container grown *Rhododendron catawbiense* during 1989.**

generation occurred May 25, which coincided with peak bud break and early leaf expansion.

The first eggs and larvae were recovered on June 2. Eggs were laid on expanding buds that had a portion of their leaves showing. No eggs were found on flower buds. Most of the eggs were recovered from newly expanding buds and leaves during the first generation, although some were also recovered from larger leaves, in damage classes 3–5, where older larvae were feeding. Eggs were not found on mature leaves, regardless of the degree of damage.

A second peak of adult emergence occurred on June 22, at the beginning of the second growth flush (Fig. 1). Peak oviposition occurred from June 29–July 6. This was followed by a smaller period of emergence and oviposition

Table 2. **Effects of irrigation on Dursban applied to the soil surface of container grown rhododendron plants for control of the rhododendron gall midge.**

Treatment	Quantity/container		Rate		Midges/container[z]	
	ml	oz	g ai/100L	lb ai/100 gal	Before irrigation	After irrigation
Control	—	—	—	—	10.8 a	10.8 a
Dursban 2E	40	1.3	119.4	1.0	0.0 b	0.0 b
	80	2.6	119.4	1.0	0.0 b	0.0 b
	40	1.3	238.8	2.0	0.0 b	0.0 b

[z]Means followed by different letter or letters are significant, Duncan's multiple range test, 5% level.

from July 13–20, during the later part of the second flush of growth. Eggs were recovered from new buds and leaves, and from damaged, infested leaves.

The third flush of growth was less distinct. Newly expanding buds were present within the nursery from August 10 until the first frost on October 5, although most growth occurred during August and early September. A fourth peak in adult emergence occurred on August 3 and peak oviposition occurred on August 10. A fifth peak of emergence occurred on August 30. Although a relatively large number of adults emerged in late August, more than 80% of them came from two containers. Adults continued to emerge in low numbers throughout the remainder of the growing season, and eggs were recovered until the beginning of October.

In general, adult emergence occurred approximately one week before peak oviposition (Fig. 1). However, this may have been the result of accelerated pupal development due to higher temperatures within the plastic bags placed over traps to prevent water damage. Therefore, under more natural conditions emergence and oviposition probably coincide.

The numbers of eggs/branch were low during the first generation in May and early June, reflecting the low number of infested branches (20%) during that time. Numbers of eggs were also low in late August and early September.

The early seasonal phenology of the rhododendron gall midge on container grown plants was similar to that reported by Specker and Johnson (2) for field grown rhododendron. In both cases, adult emergence was closely correlated with the development of the host plant, and populations increased greatly during the growing season. In addition, both studies showed that the rhododendron gall midge did not fully utilize the available buds during the first growth flush. During the present study only 20% of the buds were infested during that growth period, but by the second growth flush nearly 100% of the buds contained eggs or larvae. Early detection and treatment may prevent extensive damage later in the season. Examining plants during late May for signs of infestation should provide time to apply treatments before populations build to damaging levels.

Under laboratory conditions, this insect can complete a generation in 21 days at 25°C (77°F) (2). However, Specker and Johnson (2) found that water was a limiting factor on field grown plants. During dry periods, mature larvae aestivated on foliage until the next rainfall, increasing the time required to complete a generation. Water was not limiting on container grown plants due to irrigation. Furthermore, food was apparently not limiting, since females laid eggs on newly expanding leaves as well as larger leaves that were infested with actively feeding larvae. At least one of these food sources was available throughout the growing season. Thus, conditions in container nurseries appear to be ideal for the development of the rhododendron gall midge.

Insecticide applications directed at overwintering larvae of the rhododendron gall midge in the soil provide a good alternative to timed foliar applications. Applications can be made in late fall or early spring, providing an extended time period for treatment and minimizing the risk of worker exposure. However, soil applications should also be effective during the growing season if infestations are detected, although treatments must be made within a shorter period of time between growth flushes. Also, two applications may be required in the summer because all life stages are present after the first growth flush.

(*Ed. note:* This paper reports the results of research only, and does not imply registration of a pesticide under amended FIFRA. Before using any of the products mentioned in this research paper, be certain of their registration by contacting appropriate state and/or federal authorities.)

Literature Cited

1. Smith, F.F. and R.E. Webb. 1976. The rose midge. Amer. Rose Ann. 61:57–73.

2. Specker, D.R. and W.T. Johnson. 1988. Biology and immature stages of the rhododendron gall midge, *Clinodiplosis rhododendri* Felt (Diptera: Cecidomyiidae). Proc. Entomol. Soc. Wash. 90:343–355.

3. Valley, K. 1985. Rhododendron gall midge, *Clinodiplosis rhododendri* Felt. Regulatory Hort. 11:13–14.