HIPPELATES PUSIO EYE GNAT CONTROL
BY ULTRALOW VOLUME AERIAL SPRAYS

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ABSTRACT

Aerial ultralow volume sprays of Gardona®, 2-chloro-1-(2, 4, 5-trichlorophenyl) vinyl dimethyl phosphate, naled and malathion were evaluated against natural populations of *Hippelates pusio*. Various times of application and sizes of treated areas were used. Partial control was obtained in some cases for up to 2 days posttreatment.

Key Words: Ultralow volume, eye gnats, *Hippelates*, naled, malathion, Gardona®

*Hippelates* eye gnats (Diptera: Choloropidae) are difficult to control due to the mobility of the adults and development of the immature stages in the soil. The possibility of using ultralow volume (ULV) aerial sprays against the adult gnats has been suggested on the basis of tests of several insecticides against caged gnats (Axtell 1971). However, the effectiveness of ULV aerial sprays against mobile natural populations of eye gnats cannot be determined simply by extrapolation from the results of tests with caged insects. Therefore, large areas were treated to determine the effectiveness of ULV sprays under field conditions.

METHODS AND MATERIALS

ULV aerial applications were made in the golf course areas of Whispering Pines and Pinehurst, N. C. during August and September (1967-8) when gnat populations are highest (Axtell and Edwards 1970). The areas consisted to typical mowed fairways of varying sizes interspersed throughout pine woods, which created a light canopy. Most tests were conducted with approximately square areas of 230-480 acres. One test involved treatment of 1500 acres. With the aid of aerial photographs, treated and untreated blocks of nearly equal size, shape, and terrain were laid out to utilize easily recognized natural and man-made boundaries (such as roads). Helium-filled balloons were usually used to mark the boundaries and to guide the pilot in maintaining the proper swath width.

Chemicals and concentrations used were: 85% naled (Ortho Chemical Co.), 95% malathion (American Cyanamid Co.), and 44% Gardona® (Shell Chemical Co., 2-chloro-1-(2, 4, 5-trichlorophenyl) vinyl dimethyl phosphate.). In tests nos.

1 Paper no. 3517 of the Journal Series of North Carolina State University Agricultural Experiment Station.

2 Editors note: The paper reporting the results of those tests contained critical printing errors in the headings of table 2 and footnotes to the tables were omitted. Errata appeared with the July 1971 issue of this journal.

Disclaimer—Use of trade names in this publication does not imply endorsement of the products named or criticism of similar ones not mentioned.
1-6, 9 and 10 the insecticide was dispersed from 4 equally spaced flat-fan nozzles mounted under the wings of a single engine plane and connected to a carbon dioxide pressure system (Dearman et al. 1965). In experiment no. 7, the propeller pump of the plane was used with 8 nozzles. In experiment no. 8, 4 Mini-spin® nozzles and the propeller pump were used. A Cessena Ag Wagon® was used for experiment no. 10, a Cessena Ag Cat® for experiment no. 8 and a Piper Pawnee® for all other experiments. Actual amounts of insecticide applied per acre were calculated from total amount dispensed and measurements of the treated area on aerial photographs. With the carbon dioxide pressure system, calibrations were made on the ground also. Tests were conducted with pressures of 40-56 psi, altitudes of 75-150 ft., swath widths of 150-300 ft. and speeds of 75-100 mph. Details are given in the section on results.

The effectiveness of the treatments was measured by the mean number of gnats (predominately Hippelates pusio) landing on a person in a 5 min. interval. This was determined by collecting the gnats with a battery-powered vacuum aspirator from the same person at 2 sampling sites near the middle of each treated and untreated block. Samples were taken once each daylight hour for most of the day prior to treatment and for 1 or 2 days after treatment. A different procedure was used in experiment no. 10 in which the gnats were collected by means of 8 small traps baited with fish and placed about 300 ft. apart in a circular pattern near the middle of each block. These traps were replaced once each hour during the pre- and posttreatment sampling periods.

To evaluate the spray coverage, 10 cages of field-collected gnats were placed in a straight line at right angles to the flight path of the plane. The cages were 20 ft. apart with half in the open fairways and half under the pine trees. Each cage contained 150-200 gnats and was of the same construction described previously (Axtell 1971). The mortalities were estimated at frequent intervals up to 1 hour after spraying. Natural mortality was determined from caged gnats in the untreated area. The pattern of spray droplet distribution was observed by placing dyed cards near the cages in the treated areas but no attempt was made to quantify the results.

RESULTS

In all tests the mortality among the caged gnats in the treated areas was 90-100% within an hour after spraying. In most cases these mortality levels were reached in 20-30 minutes after treatment. The gnats exhibited symptoms of insecticide poisoning immediately after the passing of the spray plane. This was most evident with naled which often caused nearly 100% mortality within 10 minutes. Mortality among caged gnats in untreated areas was generally less than 10%.

High application rates of naled gave partial control of the gnats in the area for limited periods of time. In the first experiment (fig. 1) the population of gnats was higher in the treated area than in the untreated block on the day preceding spraying. After an early morning application of naled at 1.5 oz/A, there was substantial reduction of the gnat population in the 420 A treated block (31% control compared to pretreatment counts) while the untreated area had gnat counts about equal to the pretreatment counts. Gnat control was most obvious in the 4-hr posttreatment period.

A second experiment (fig. 2) utilized a smaller treated area (270 A) treated at a higher dosage of naled (2.4 oz/A) applied later in the morning when the gnats
Control of eye gnats in a 420 A block by aerial application of 1.5 oz/A of 85% naled. Treated 7:30-8:30 am (arrow), Aug. 15, Whispering Pines, N. C., No. 800067 nozzles (4), 85 mph, 44 psi, 150 ft swath, 75 ft altitude, 72° F, 90% RH.

were more active. Comparing post- to pretreatment counts, there was no gnat control. However, comparing the counts on the posttreatment day, there was a slight control of the gnat population for about 3 hrs after spraying but none for the remainder of the day. Early morning treatment of a similar small area with naled at about the same application rate (fig. 3) resulted in obvious control for the 4-hr posttreatment period but only slight control for the entire day. The gnat population was lower in the treated area than in the untreated area on the second day after treatment although it was higher on the pretreatment day. Later in the season (expt. 9, August 30), an application of 2.5 oz/A of 85% naled to the same 230 A area resulted in 36% reduction of the gnats during the day following the early morning treatment (8:15-8:45 am). Most of the gnat control was during the 4-5 hrs after spraying.

Late afternoon treatment (fig. 4) of a 450 A block with naled (1.4 oz/A) resulted in an immediate reduction in the gnat population prior to the onset of darkness when gnat flight activity ceases. During the day following the spray application, the gnat population was substantially lower in the treated area than in the untreated area although the 2 areas had about the same level of gnat
Figure 2. Control of eye gnats in a 270 A block by aerial application of 2.4 oz/A of 85% naled. Treated 9:00-10:00 am (arrow), Aug. 15, Pinehurst, N. C., No. 800067 nozzles (4), 85 mph, 44 psi, 100 ft swath, 80° F, 62% RH.

Figure 3. Control of eye gnats in a 230 A block by aerial application of 2.5 oz/A of 85% naled. Treated 7:30-8:30 am (arrow), Aug. 16, Whispering Pines, N. C., No. 800067 nozzles (4), 85 mph, 48 psi, 150 ft swath, 75 ft altitude, 78° F, 90% RH.
Control of eye gnats in a 450 A block by aerial application of 1.4 oz/A of 85% naled. Treated 4:00-4:45 pm (arrow), Aug. 16, Whispering Pines, N. C., No. 800067 nozzles (4), 85 mph, 44 psi, 150 ft swath, 75 ft altitude, 86° F, 54% RH.

Interpretation of the results of an early morning treatment (fig. 5) of 480 A with a high application of naled (2.3 oz/A) is difficult due to the light rain occurring most of the day. On the second day after treatment the gnats were 48% less abundant in the treated area than in the untreated area.

Late afternoon and early morning treatments with naled (2.5 oz/A) were combined (fig. 6) in an attempt to increase the level of gnat control in a 480 A block. The gnat populations were substantially lower during the day preceding spraying in the untreated area than in the area to be treated. After spraying, the situation was reversed with the lowest populations in the treated area. Comparing the post- to pretreatment counts in the treated area, there was 47% control during the first posttreatment day and 39% during the second. The gnat numbers were only slightly higher in the untreated areas during the 2 days posttreatment than they were on the day preceding spraying.

In a companion experiment (fig. 7), using the same control area as in experiment 6, malathion treatment partially controlled the gnats in a 340 A block.
Control of eye gnats in a 480 A block by aerial application of 2.3 oz/A of 85% naled. Treated 6:30-7:30 am (arrow) Aug. 23, Whispering Pines, N. C., No. 80015 nozzles (4), 85 mph, 56 psi, 200 ft swath, 75 ft altitude, 73°F, 90% RH.

Control of eye gnats in a 480 A block by aerial application of 2.5 oz/A of 85% naled, twice (arrows): 3:30-4:45 pm, Aug. 29 and 6:30-8:00 am, Aug. 30, Whispering Pines, N. C., No. 80015 nozzles (4), 75 mph, 50 psi, 200 ft swath, 75 ft altitude.
Figure 7. Control of eye gnats in a 340 A block by aerial application of 7.5 oz/A of 95% malathion. Treated 5:20-6:00 pm (arrow), Aug. 29, Whispering Pines, N. C., No. 8002 nozzle (8), 75 mph, 50 psi, 200 ft swath, 78° F, 72% RH.

for the 2 days following a late afternoon spraying. Prior to treatment the gnat counts were substantially lower in the untreated area than in the area to be treated. After spraying, the counts were reversed. Comparing the post- to pretreatment counts in the treated area, there was 41% control during the first posttreatment day and 47% during the second.

In another experiment (fig. 8), a mixture of malathion and naled was applied to a 460 A block in the morning with no evidence of gnat control resulting. However, mortality among caged gnats in the treated area was 90.2%. This treatment was different from the others since "Mini-spin" nozzles were used and no balloons were used to mark the area.

The partial control of eye gnats achieved in these experiments suggested that treatment of larger areas might improve the level of control. Therefore, 1500 A blocks were treated in the morning with naled and Gardona (Experiment 10). As shown in table 1, the gnat population remained high in the untreated area during the day of the spraying and the following morning. During the afternoon after treatment (day 1) there was 65% gnat control in the naled-treated block and 48% control in the Gardona-treated block. During the following morning (day 2) there was 55% and 34% control from the 2 insecticides, respectively. During the interval including the afternoon of day 2 and the morning of day 3, there was 27% control in the naled-treated block and 35% control in the Gardona-treated block. Little or no control was evident after that time and extremely hot, dry weather caused a general decline in gnat activity in the entire region.
Control of eye gnats in a 460 A block by aerial application of 11 oz/A of a 1:6 mixture of 85% naled and 95% malathion. Treated 7:15-8:15 am, Sept. 20, Pinehurst, N. C. Mini-spin nozzles (4), 85 mph, 200 ft swath, 71°F.

Control of eye gnats in 1500 A blocks treated with naled (1.4 oz/A) and Gardona (3 oz/A). Treated Aug. 21, 1968. Cessena AgWagon with 4 nozzles and CO₂ pressure system, 100 mph, 150 ft altitude, 200-300 ft swath.

Table 1. Control of eye gnats in 1500 A blocks treated with naled (1.4 oz/A) and Gardona (3 oz/A). Treated Aug. 21, 1968. Cessena AgWagon with 4 nozzles and CO₂ pressure system, 100 mph, 150 ft altitude, 200-300 ft swath.

<table>
<thead>
<tr>
<th>Day No. &amp; Time</th>
<th>Mean No. Gnats Trapped/Hr</th>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
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<tr>
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<td>19.4</td>
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<tr>
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</tr>
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<td>25.5</td>
</tr>
<tr>
<td>4 (AM)- 5 (PM)</td>
<td>25.7</td>
</tr>
</tbody>
</table>

a 8 traps placed in a circle near the center of each area.
b Treated 8:30-11:00 am, No. 730116 nozzles, 58 psi.
c Treated 6:00-8:00 am, No. 8002 nozzles, 58 psi.
d % control compared to the untreated area is in parenthesis.
DISCUSSION

This series of ULV aerial application experiments demonstrated only a moderate degree of eye gnat control although high insecticide application rates were used. Based on our results, eye gnat control is difficult to achieve by aerial ultralow volume techniques. About 50% control may be expected for the day following treatment and possibly some control during the second day.

The relatively poor control by ULV aerial applications may have been due to: (1) inadequate contact between the insecticide droplets and the resident gnat population and/or (2) rapid reinvasion of the sprayed areas by gnats from the surrounding untreated area. The high and rapid mortality among the caged gnats placed in the flight path of the plane tends to contradict the first possibility. However, caged insects are more vulnerable than the wild ones which might be sheltered among the vegetation and ground litter. There is inadequate data on the resting behavior of *H. pusio* for further speculation.

Reinvasion appears to be a strong possibility since *H. pusio* are known to be very mobile (Dow 1959). However, this explanation is partially contradicted by the presence of substantial numbers of gnats in treated areas within an hour after treatment and by the similarity of the level of control in the 1500 A blocks and in some smaller blocks.

Although control obtained in these tests was less than expected, ULV aerial applications of insecticides should be evaluated further against eye gnats. Repeated insecticide applications at relatively low rates to very large areas might cause sufficient cumulative adult gnat mortality to be practical. Also, the timing of applications could be of major importance. Perhaps the applications should be aimed at the early season population rather than waiting until the gnats become very abundant and pestiferous. The overwintering population is low and if their oviposition in the spring is drastically reduced, the consequences will be magnified later in the season.

ULV aerial insecticide application for eye gnat control should be further investigated in the context that it is only one of several techniques for use in a pest management program. Partial control by insecticides could be a useful tool in such a program. The ecological side effects of the insecticide treatment will need to be considered. Ultimately a management program for eye gnats will probably involve an area-wide integrated approach based on cultural control (reduction of soil disturbance), biological control agents, and strategic use of minimal amounts of short-lived adulticides.

LITERATURE CITED


J. Georgia Entomol. Soc. 7(2) April, 1972 pp. 119-27.