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# Toxicity of Fluometuron and Diuron on the Intermediate Snail Host (*Lymnea* spp.) of *Fasciola hepatica*

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Fasciola hepatica, a parasite of sheep and other mammals including man, is continously perpetuated through its intermediate snail host (Lymnea sp.) and its asexual development inside this host. The survival and propagation of the lymnaeid snails are therefore, very important to the survival of the flukes. Asexual development inside the snail is an important phase in the life cycle of F. hepatica, since it gives rise to the infective stage (metacercariae). Therefore, an effective control of the intermediate snail host (Lymnea sp.) would significantly reduce fascioliasis (Liver fluke infections).

Fluometuron and diuron are urea herbicides used for weed control in cotton and sugarcane. They are known to inhibit the Hill reaction which involves the oxygen evolution site of the photosystem II (HAYES 1975; WARE 1978). The inhibition prevents the formation of ATP and NADPH which are necessary for $CO_2$ fixation (CRAFT 1979; CORBETT 1974). Previous studies performed with fluometuron included its effect on embryonation and hatching of F. hepatica's miracidia (CHRISTIAN & TATE 1982). These herbicides were selected because of their common usage in the Gulf Coast areas and to determine their effect on non-target organisms.

In this study, the effects of fluometuron and diuron were experimentally assessed on the lymnaeid snails which are non-target organisms of these herbicides.

## MATERIALS AND METHODS

The ninth generation of laboratory reared lymnaeid snails were used in this study. The snails were cultured in plastic containers containing mud, artificial spring water and leaves. The mud in the containers was elevated on one end so the snails could crawl out of the water onto the mud; this simulated environmental conditions. They were fed lettuce leaves and cerophyl ad libitum (MALEK 1982).

Experimentation was performed in 10 replications. Ten snails were removed from the containers and placed in dishes containing varying concentrations of each pesticide (0-100 ppm). Snails were restrained in pesticide solutions with wire chambers to prevent them from crawling out of the solutions. The snails were observed at intervals of 24, 48, 72 and 96 h. The number of dead snails were counted and removed from the containers daily.

Snails in artificial spring water served as controls.

1% stock solutions of both diuron and fluometuron were made and diluted with distilled water to obtain desired concentrations. Stock solutions were dissolved in acetone (solvent), and preliminary studies were performed to determine the effects of acetone on the snails. Concentrations levels used were the same as those used in this study (0-100 ppm).

Statistical analysis (FINNEY 1971) performed on data included: linear regression analysis which provided us with r-value (correlation coefficient), analysis of variance (ANOVA) and LC50 (lethal concentration for 50% mortality).

## RESULTS AND DISCUSSION

Results from preliminary studies done with acetone showed that this solvent had no noticeable effects on the lymnaeid snails. The mortality rate of the snails at time intervals of 24, 48, 72 and 96 h in diuron is shown in Table 1. The r-values calculated for the above stated time intervals were 0.90, 0.86, 0.86 and 0.72, respectively. These values show that the results were highly correlated. ANOVA shows the values of each time interval to be significant at $P < 0.01$. The results also show that as concentrations and time of exposure increase, the percent mortality increases.

Table 1. Mortality Rate of Lymnaeid Snails Exposed to Diuron.

| Concentration (ppm) | % Mortality 24 h | % Mortality 48 h | % Mortality 72 h | % Mortality 96 h |
|---|---|---|---|---|
| Control | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 10 |
| 10 | 0 | 0 | 0 | 40 |
| 20 | 10 | 10 | 20 | 100 |
| 30 | 40 | 50 | 60 | 100 |
| 40 | 80 | 100 | 100 | 100 |
| 50 | 100 | 100 | 100 | 100 |
| 60 | 100 | 100 | 100 | 100 |
| 80 | 100 | 100 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 |
| r-value | 0.90 | 0.86 | 0.86 | 0.72 |
| ANOVA | $P < 0.01$ | $P < 0.01$ | $P < 0.01$ | $P < 0.01$ |

The toxicity of fluometuron on the lymnaeid snails is shown in Table 2. The same time intervals were used and r-values were calculated to be 0.97, 0.97, 0.95 and 0.92, which show that values were highly correlated as time progressed. ANOVA shows singifi-

cance levels of $P < 0.01$ for fluometuron. As exposure time and concentration levels increase, the percent mortality increases.

Table 2. Mortality Rate of Lymnaeid Snails Exposed to Fluometuron

| Concentration (ppm) | % Mortality 24 h | % Mortality 48 h | % Mortality 72 h | % Mortality 96 h |
|---|---|---|---|---|
| Control | 0 | 0 | 0 | 0 |
| 1 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 |
| 20 | 0 | 0 | 0 | 0 |
| 30 | 10 | 20 | 20 | 70 |
| 40 | 20 | 40 | 50 | 80 |
| 50 | 40 | 60 | 80 | 90 |
| 60 | 40 | 70 | 80 | 90 |
| 80 | 80 | 90 | 100 | 100 |
| 100 | 100 | 100 | 100 | 100 |
| r-Value | 0.97 | 0.97 | 0.95 | 0.92 |
| ANOVA | $P < 0.01$ | $P < 0.01$ | $P < 0.01$ | $P < 0.01$ |

The LC50 values for diuron and fluometuron is shown in Table 3. These values show that the mortality rate in diuron is much higher than the mortality rate in fluometuron. At each time interval, diuron was almost twice as effective as fluometuron, based on the LC50 values shown in Table 3.

Table 3. LC50 Values of Diuron and Fluometuron on Lymnaeid Snails

| Time (h) | Diuron Concentration (ppm) | Fluometuron Concentration (ppm) |
|---|---|---|
| 24 | 33.2 | 59.7 |
| 48 | 30.3 | 49.5 |
| 72 | 28.6 | 43.6 |
| 96 | 15.3 | 34.7 |

Results obtained from each herbicide showed a dosage-dependent relationship. Both diuron and fluometuron can be used as a controlling agent for lymnaeid snails but, diuron would be the most effective controlling agent.

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