2003 TAIWAN INTERNATIONAL SCIENCE FAIR

CATEGORY：Botany

PROJECT TITLE ：The Flying Chloroplasts Drug Test

AWARD：First Award

SCHOOL：St. Margaret's School

FINALISTS：Julia Hulbert

COUNTRY：Canada

The Flying Chloroplasts Drug Test

Julia Hulbert

Previously, I studied the acute effects of a common broadleaf herbicide, Killex (by Montsano) and a pesticide, Spidercide (by Wilson), on cytoplasmic streaming in detached leaves from the pond weed, *Elodea canadensis.* I found that Killex, active ingredient 2-4D, an auxin analog, applied at the recommended dose decreased the rate of cytoplasmic streaming by 64% over a 20 minute observational period. The Spidercide, active ingredient d-trans allethrin, a Na+ channel activator, stopped cytoplasmic streaming after a 5 minute exposure and no recovery was observed during the 20 minute observational period.

In this study, the possible mechanism(s) causing the decrease in cytoplasmic streaming and their long term effects after acute exposure to Killex and Spidercide were examined as follows. Qualitative analysis of ATP levels and the addition of extracellular ATP; exposure to a graded osmotic series; incubation in deionized water; assessment of streaming at pH 9.0, (the pH of Spidercide); evaluation of recovery of streaming over a 4 hr period; and, determination of plasma membrane bioelectrical potentials correlated in time sequence with rates of cytoplasmic streaming.

ATP levels decreased after exposure to Killex but increased with Spidercide. Adding extracellular ATP partially restored rates of streaming following Killex treatment. Streaming decreased with treatments of 300, 400, and 500mOsm solutions. In all cases, varying degrees of plasmolysis were observed. By contrast, plasmolysis was never observed following treatment with either toxic agent. Incubation in deionized water showed that Spidercide inhibited streaming regardless of incubation time (up to 4 hours) indicating that extracellular ions may not participate in the Spidercide effect. Incubating leaves in pH 9.0 water had no effect on rates of streaming, thus confirming that the Spidercide effect was not due to its pH. The 4 hour recovery experiments following Killex exposure showed complete recovery of cytoplasmic streaming by 1 hour with continued increases above control at 4 hours post-exposure. By contrast, rates following Spidercide exposure recovered later at 2 hours post-exposure and increased above control levels only at 4 hours post-exposure.

The toxic agents affected membrane bioelectrical potentials differently. Spidercide caused an immediate hyperpolarization that was followed by depolarization; this coincided with an increase and then a decrease in streaming rates. Killex caused a delayed depolarization coinciding with a decrease in cytoplasmic streaming. The rate of membrane depolarization with Spidercide was 2.5mV/min. but it was 9.3mV/min. with Killex.

Spidercide altered membrane phototaxis as it caused a hyperpolarization when the white light was turned off, Killex had no such effect. Cytoplasmic streaming with Spidercide stopped when the membrane potential was -130mV, but with Killex, it plateaued at approximately 1/3 of control where membrane potentials were between -115 and -120mV.

I conclude that the acute effects of both toxic agents on cytoplasmic streaming are reversible and, the subtle differences observed from the various experimental procedures suggest different mechanisms of action. Killex affects energy availability and is less disruptive on membrane function and cytoplasmic streaming than Spidercide is; however, Spidercide caused toxic non-target effects on *Elodea canadensis*.

評 語

The experiments are well designed and executed and the results are significant. However, due to the quantity of data, the presentations (oral, poster) may be needed to be more concise and clarified. Overall, it is an excellent project with high level of originality.