

# Examining the Individual and Combined Effects of Roundup's Disclosed Ingredients on the Activity Levels of *C. elegans*

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New Hampshire Academy of Science - 2017

Roundup, produced by the company Monsanto, is the most widely used commercial herbicide. It is a selective, broad-spectrum preparation containing the active ingredient glyphosate, polyethoxylated tallow amine (POEA), and other undisclosed ingredients. Monsanto claims Roundup does not pose a risk to humans as glyphosate targets the shikimic acid pathway, which is not found in animals. Despite this line of reasoning, glyphosate was classified as “probably carcinogenic to humans” by the International Agency for Research on Cancer in 2015. POEA is a surfactant that facilitates glyphosate adherence to foliage. Recently published studies suggest that the addition of POEA to glyphosate increases its efficacy as an herbicide. This investigation examines the individual and combined effects of Roundup's known ingredients, glyphosate and POEA, as well as the complete commercial preparation, on the activity of the non-parasitic nematode, *C. elegans*. The activity levels of the worms were monitored during exposure to varying concentrations of: a) Roundup Weed and Grass Killer Super Concentrate at concentrations below and above that recommended for residential use, b) pure glyphosate, c) pure POEA, and d) the combination of glyphosate and POEA. The substances were serially diluted in M9 growth medium. The responses of unsynchronized *C. elegans* were measured over 8 different time periods (from 0 to 150 minutes) using an activity level scale ranging from 0 to 3, with 0 indicating no movement and 3 indicating rapid sinusoidal movement. Exposure to Roundup, glyphosate alone, and the combination of glyphosate with POEA resulted in a statistically significant dose-response pattern with the activity levels declining more rapidly over time with increased concentration. Exposure to POEA alone demonstrated no significant effect on activity. When effects were compared across substances, glyphosate alone caused a greater decrease in worm activity compared to POEA alone. A modest, however statistically significant difference ( $p < 0.05$ ) was observed between exposing the worms to glyphosate alone and the combination of glyphosate and POEA, with the combination having a more detrimental effect. This result suggests an additive effect between POEA and glyphosate. However, further investigation is necessary to verify a potential interaction between glyphosate and POEA. Future research will also investigate the effects of Roundup, POEA, and glyphosate at additional concentrations over greater periods of time. This will include replacing the activity level as a measure of toxicity with the measurement of fecundity with synchronized larval stages as a more accurate scale to understand the compounding effects of Roundup's known ingredients.