New research shows link between agrochemicals and risk of parasitic disease

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Farmers worldwide face mounting pressure to increase agricultural yields to keep up with human population growth. Consequently, chemical use is on the rise – in many cases a cocktail of chemicals, from fertilizers to herbicides to insecticides. But in countries where human population growth is highest, including China, South East Asia and South America, these chemicals can set off a chain of events that ultimately puts people at far greater risk of contracting a devastating parasitic disease caused by blood flukes.

This disease, called schistosomiasis, is second only to malaria among parasitic diseases with the greatest economic impact, with a quarter of a billion people currently infected and nearly a billion more at risk. Unfortunately, those most at risk are children, and those affected will suffer from stunted growth, anemia and learning difficulties. If untreated, it can result in liver damage, kidney failure, infertility and cancer.

I collaborated with an international team to investigate the impact of changes in the concentration of agrochemicals on the risk of human infection with this disease. Using laboratory experiments (in the U.S.), field studies (in Senegal) and predictive computational modeling (in Australia and the U.S.), we showed how the use of common agricultural chemicals can increase the risk of transmission of this widespread infectious disease. The resulting paper, recently published in *Nature Communications*, quantifies the connection between agrochemicals and increased predicted schistosomiasis risk in humans for the first time.

The parasite that causes schistosomiasis spends its life in three main locations: A snail host, water (such as irrigation water, reservoirs, lakes or rivers) and a human host. Increasing the concentration of agrochemicals impacts an ecosystem in two common ways: Increased algae in water sources, resulting in snail population growth, and a decrease in the snail's natural predators (as they are inadvertently killed by these chemicals). An increase in food supply (algae) and decrease in predators means a boom in the snail population, and as a result, a boom in the number of schistosomiasis-infected snails. When the number of infected snails increases, the number of infected water sources increases, putting more humans at risk of infection.

The most common way of measuring infectious disease transmission risk is the "basic reproduction number," R0. An R0 less than 1 indicates that the disease will not persist; when it's greater than 1, it will. The higher the value of R0, the higher the transmission risk. We find that, in the absence of agrochemicals, R0 is significantly less than 1 and, in the presence of various combinations of chemicals, the median R0 value goes up to about 3.5.

This study is a powerful example of how a multidisciplinary effort can disentangle and explain a very complex interaction between humans and the environment. While we have mathematically confirmed the link of growth in snail population and human risk of disease, we have yet to validate the linkage in field studies. However, this study clearly shows the urgent need to investigate how we can improve our agricultural practices to ensure the safety of our food, population and planet.

A multitude of choices in agrochemicals exist today, and we hope to use computational screening of combinations of these chemicals to help ensure high crop yields while decreasing risk of disease. Our study shows that this is possible and could one day inform the combinations of chemicals used in agriculture.

More information: Neal T. Halstead et al. Agrochemicals increase risk of human schistosomiasis by supporting higher densities of intermediate hosts, *Nature Communications* (2018). DOI: 10.1038/s41467-018-03189-w

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