Selective application of contraceptives may be most effective pest control

17 May 2019

Credit: Northern Arizona University

Since the mid-20th century, the global human population has grown from 2.5 billion to 7.7 billion, according to the most recent United Nations estimate. Much of this growth was due to the unprecedented agricultural expansion made possible by the widespread use of synthetic pesticides starting in the 1950s.

By applying pesticides to prevent a variety of insects, rodents and birds from damaging crops, farmers increased productivity by between 20 and 50 percent and maximized the benefits of other valuable agricultural tools, such as high-quality seeds, fertilizers and water resources.

As pests evolved and developed resistance to pesticides, however, they passed on these genetic factors to their offspring, which resulted in higher proportions of these populations becoming pesticide-resistant. The pest control industry then developed stronger and more concentrated treatments, which led to further increases in pesticide resistance within the targeted populations. Although repeating this cycle with higher and higher treatment concentrations may work in the short term, scientists agree it will ultimately lead to increasingly resistant populations, a process that threatens to make most pesticides obsolete.

"Evolved resistance to pesticides is now recognized as one of the most significant problems of modern times," said Stephen Shuster, professor of invertebrate zoology in NAU's Department of Biological Sciences.

Study finds contraceptives have significant implications for pest management

Shuster conducted a new study focused on genetic factors that contribute to pesticide resistance in rats, which proposes a different approach to pest control through the use of contraceptive treatments. Shuster collaborated on the study, published in the journal *Heliyon*, with scientists Cheryl Dyer, Loretta Mayer and Brandy Pyzyna of SenesTech, a local Flagstaff firm with many ties to NAU. Dyer was formerly a research professor in NAU's Department of Biology. Mayer is an alumna, earning both her master's and Ph.D. degrees in biology at the university. Pyzyna also earned her master's degree in biology at NAU.

"Our results have significant implications for the development and application of treatments to manage pests, now and into the future," Shuster said.

The team examined a number of pest control approaches, including three primary solutions already proposed to mitigate this growing problem: withholding treatment altogether; selectively applying treatment; and applying treatments in combination.

After running extensive simulations on rat reproduction to understand the intense selection process that results in evolved pesticide resistance, the scientists found that because pesticides and

sterilants rarely eradicate an entire pest population, they impose powerful selection favoring the evolution of resistance to pesticide treatment.

In contrast, contraceptives act to reduce pest population size by targeting particular age classes. This process limits population growth and keeps genetic factors that confer resistance at such low frequency that they can be lost from the population by chance.

"Our overall conclusion is that we can mitigate the selection responsible for the evolution of pesticide resistance by changing the usual goal of pest control treatments. Instead of attempting, and ultimately failing, to destroy or sterilize an entire pest population, we advocate the use of contraceptive treatments that primarily act to reduce these species' rates of reproduction, and that leaves as much of the pre-treatment population as possible intact," Shuster said. "We show that this approach dramatically reduces the opportunity for selection favoring the evolution of resistance and may thereby permit the safe and long-term application of pest control measures."

Shuster's main research interests are mating system evolution, male and female reproductive strategies, community and ecosystem genetics and population biology of marine organisms. In 2017, Shuster was named an American Association for the Advancement of Science (AAAS) Fellow, recognized by his peers for "distinguished contributions to the fields of invertebrate zoology, mating system and sexual selection research, and for undergraduate science education and communicating science to the public."

More information: Stephen M. Shuster et al. The opportunity for sexual selection and the evolution of non-responsiveness to pesticides, sterility inducers and contraceptives, *Heliyon* (2018). DOI: 10.1016/j.heliyon.2018.e00943

Provided by Northern Arizona University