Small, self-controlled planes combine plant pathology and engineering

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Dr. David Schmale prepares plane to collect Fusarium samples. Credit: Photo courtesy of David Schmale

A Virginia Tech plant pathologist has developed autonomous unmanned aerial vehicles (UAVs) to detect airborne pathogens above agricultural fields.

David Schmale, assistant professor of plant pathology, physiology, and weed science in the College of Agriculture and Life Sciences, has not only linked agriculture and engineering with his interdisciplinary research but has also given scientists an unprecedented glimpse into the life of microorganisms hundreds of meters above the surface of the earth.

“Until recently, researchers used autonomous UAVs for military applications, but now we can apply this cutting-edge technology to agriculture,” said Schmale, who is an affiliate faculty member in the Virginia Center for Autonomous Systems (VaCAS), a Virginia Tech research center that facilitates collaboration related to autonomous systems in the College of Engineering, the College of Agriculture and Life Sciences, and the College of Natural Resources.

Scientists have used aircraft to monitor the movement of airborne pathogens for years, but Schmale is the first plant pathologist to use an autonomous system for this process.

“Autonomous UAVs have distinct advantages over a sampling aircraft operated via remote control,” Schmale explained. “First, the autonomous UAVs maintain a very precise sampling path. We can establish a GPS waypoint in the center of an agricultural field, and the autonomous plane can circle around the waypoint at a set altitude, with about a meter variation up and down. Second, the autonomous technology enables us to have coordinated flight with multiple aircraft. In other words, we can have two aircraft sampling pathogens at the same time but at different altitudes.”

Schmale has used the small, self-controlled planes to collect samples of the fungal genus Fusarium tens to hundreds of meters above the surface of the earth. This genus contains some of the world’s most devastating plant and animal pathogens and remains largely a mystery to scientists who do not have a firm understanding of its ability to travel long distances in the atmosphere. By placing antibiotics in the sampling collection plates, researchers can ensure that only Fusarium will grow on the plates. Over the course of 75 different UAV-sampling flights above agricultural fiends at Virginia Tech’s Kentland Farm, Schmale and his colleagues collected more than 500 viable colonies of Fusarium, representing at least a dozen species.

“For 11 of these Fusarium species, this is the first report of their ability to be transported great distances above the surface of the earth,” Schmale said. “Our work has important implications for the rapid spread of invasive plant and animal pathogens in the United States.”

Schmale’s research is not limited to the study of Fusarium, however. He has expanded his interests to explore entire microbial populations in the atmosphere—a type of research he calls “aerogenomics.”

“One of the species we collected with our autonomous UAVs appears to be a bacterium known only to exist in a cavern in Arizona,” he said. “What was that bacterium doing 100 meters above Kentland Farm" In many of our other samples, we have found organisms that have never been cultured before. Some of these microbes may thrive only in the atmosphere, and many of them may be new to science.”

This and other fascinating results have led Schmale to hypothesize that some airborne microorganisms have “novel biochemical processes for interacting with each other as a community of organisms in the atmosphere.” He explained, “We know that microbes mediate important biochemical processes in the soil and the ocean. It is not so farfetched that a similar drama unfolds in the atmosphere, which we already know is teeming with microbial life.”

Although Schmale is not currently conducting his research for the armed forces, his work has a definite biosecurity element.

“Many plant pathogens are transported over long distances in the atmosphere, threatening agriculture in the United States from both inside and outside the borders of the country,” Schmale said. “An increased understanding of the dynamics of plant pathogens in the atmosphere is essential for establishing effective quarantine measures, preventing the spread of plant disease, and mitigating potentially damaging events

targeted at our nation's agriculture and food supply."

Source: Virginia Tech