Biology

Christine Mlot reports from Washington, D.C., at the National Research Council Symposium on Pesticide Resistance Management

A complex diet for mildew

Over the past four years, researchers from Cambridge University in England have driven around Norfolk and Suffolk in a car outfitted with a rooftop plant stand. The crate-sized box, actually a fungus trap, collected airborne mildew spores onto barley seedlings that researchers monitored to see how many spores had become resistant to newly introduced fungicides.

They found, not surprisingly, the whole population of barley mildew turning increasingly resistant. Globally, this pattern has become more common as synthetic fungicides have been introduced in the last 15 years. Plant pathologists now count about 100 species of microorganisms resistant to pesticides.

Aside from the cartop monitoring, Cambridge scientist Martin S. Wolfe and colleagues looked at ways to slow the mildew's development of resistance. Planting a variety of barley in one field, they reasoned, should make the mildew less efficient at infecting any one of the barley types. When they compared barley yields from different planting patterns, they found that the mixture of barley varieties gave higher yields than did single-variety crops and kept the mildew under control with reduced fungicide treatment and even without treatment. Wolfe says this can at least delay resistance to new chemicals, though pathogens will probably always find a way around any control. The best resistance management, says Wolfe, is to present a "more and more complex evolutionary problem for the pathogen rather than presenting it with the whole plate at once."

To shoo a fly

The housefly has shown resistance to all classes of insecticides, with the possible exception of the flyswatter. Though not considered an agricultural pest, the housefly can carry some diseases and has earned a pesky reputation in homes, stockyards and picnic grounds. Now the resistant housefly might redeem itself by serving as a model for understanding the genetics of resistance in insects as a whole. "It's the mouse of entymology," says Frederick W. Plapp of Texas A&M University in College Station. And, according to Plapp, the genetic basis behind the fly's resistance may be a simple one, despite the variety of chemicals the fly can withstand.

Instead of a large number of genes that each account for resistance to a different kind of insecticide, Plapp thinks there may only be a few genes that oversee the fly's defenses against insecticides. Such regulating genes "turn on" other genes that, for example, make enzymes to detoxify the chemical at hand.

Plapp bases his model on studies of mutant fly strains, but other scientists have more complex interpretations of the fly's genetics based on the same evidence. Whatever the genetic model may be, houseflies, along with fruit flies, are shaping the way scientists consider the growing problem of resistant insects. To date, 447 insect species — up from 224 in 1970 — have demonstrated resistance, and 59 percent are agricultural pests.

Rat tale

Rodents have joined the resistance to chemical control. Ten years after the rodenticide warfarin was introduced in the 1950s, rats began to develop resistance, and warfarin-proof rats have been found in 45 of 98 U.S. cities. Now the first signs of resistance to the warfarin replacements have been reported in Europe.

An even greater, though lesser known, problem, according to William B. Jackson of Bowling Green State University in Bowling Green, Ohio, is warfarin resistance in mice. Jackson estimates, based on a few samples, that half the mice in urban infestations may be resistant. Mice have more contact with humans than do rats and can carry diseases, but seem to be better tolerated. Jackson says for both rat and mouse control, urban sanitation is "exceedingly important."

Physical Sciences

The way the droplet bounces

Raindrops have been splashing into puddles for a long time. Yet the question of exactly what happens when drops of water strike a pool's surface remains largely unanswered. Do water droplets rebound after they hit the water's surface, or does the liquid capture the droplets immediately?

In the case of droplets less than a millimeter in diameter and pools about 20 centimeters deep, the answer seems to depend on the liquid's surface tension, the angle and speed at which the droplet plows into the liquid and whether the surface has been previously disturbed. These results from a nuclear engineering research group at the Massachusetts Institute of Technology (MIT) appear in the Nov. 2 SCIENCE.

The researchers found that within the range of initial velocities and droplet diameters tested, single droplets are always absorbed. Such a droplet loses so much energy in forming a large "crater" when it obliquely hits the water surface that it lacks the energy to escape the tug of surface tension. However, if a stream of droplets hits the water's surface, after the first few "sacrificial" dives, all succeeding droplets rebound. These latecomers encounter a partially formed trough and need to do less work to form their own craters. In this way, the later droplets retain enough kinetic energy to escape from the liquid's surface.

Michael W. Golay and his group also observed that at a particular impact angle, a droplet can even hop across a liquid surface, like a stone skipping on water. Eventually, the droplet comes to rest and quietly sits on the liquid surface just for a moment before it is finally gobbled up.

"The main thing that we showed is that surface tension is very important," Golay says. "We also provided a phenomenological description of what's going on. But the work that we did goes only one step of the way." Further research is needed to show how water depth affects a small droplet's bounce.

Information like this may eventually be very useful wherever liquid droplets in flowing gases occur. "You're interested in knowing," says Golay, "whether or not when they strike surfaces they will stay there." These applications include the design and analysis of turbines, cooling towers, steam generators in nuclear reactors, many chemical processes and even the transport of salt-carrying spray inland from oceans.

Stacking a new semiconductor sandwich

Semiconductors, the raw materials that form the basis for a vast array of electronic devices, are taking on surprising new properties with the rapid development of novel techniques for building them. In the last few years, a great deal of attention has focused on "superlattices," carefully constructed semiconductor sandwiches that consist of stacks of extremely thin layers of different crystalline materials (SN: 6/11/83, p. 373). More recently, several laboratories have started to build superlattices made up of layers of amorphous materials, in which the atoms are not neatly arranged as they would be in a crystalline material. Now, as reported in the Oct. 15 PHYSICAL REVIEW LETTERS, two University of Chicago physicists have synthesized the first "doping-modulated, amorphous-semiconductor" superlattice.

The new multilayer structure, created by Hellmut Fritzsche and James Kakalios, consists of alternating layers of hydrogenated amorphous silicon, one layer doped with phosphorus atoms to produce an n-type semiconductor and the next layer doped with boron atoms to produce a p-type semiconductor. Each layer is only 100 to 200 atoms thick. One of the most striking properties of this new material is its "persistent photoconductivity." When the material, at room temperature, is briefly exposed to light, its ability to conduct electricity increases and stays high for days or weeks after the light is turned off. This effect offers the possibility of using light to "tune" the material's electrical properties for particular applications.