Measuring PM –10 Dust in Cotton

Tillage systems can make a difference

Drive down a dirt road or till an open field and you're bound to raise some dust. Are you violating air quality standards? Yes, if your emissions exceed current standards for airborne particulates that are less than ten microns in diameter (PM–10). Since the late 1980s, when the Yuma-Somerton area and parts of Maricopa County were found to be in violation of the National Ambient Air Quality Standards (NAAQS), work has been underway to evaluate different minimum tillage systems to reduce emissions.

At the request of the Arizona Department of Environmental Quality, a UA agricultural engineer has been measuring particulate emissions from five different tillage systems and has evaluated the appropriateness of an equation used by the EPA to estimate emissions in Yuma-Somerton and other areas. In his work he is quantifying particulate emissions from tillage operations and assessing the magnitude of reduction that would be obtained if reduced tillage practices were adopted.

"In the EPA analysis, forty percent of the emissions were attributable to agriculture, forty percent were from dirt or gravel roads and twenty percent were from everything else," says Wayne Coates, from the UA Office of Arid Lands Studies in the College of Agriculture. "We measured all field tillage operations for five different tillage systems during three cotton seasons. We found the initial equation was wrong to begin with. The EPA was overestimating because the base equation, known as the AP–42 emission factor equation, has only one variable in it: silt content."

This is a problem, Coates says, because "the equation does not take into account potentially important factors such as implement velocity, implement type or soil moisture content." To test it, he compared the actual measured emissions from the following systems: conventional tillage, USM (uproot/shredder/mulcher), a stalk puller, modified conventional and Sundance (developed at Sundance farms in Coolidge).

He also projected emissions from these systems using the AP–42 equation and compared the results with his measurements. The measured emissions were half of those predicted by the equation. Coates has testified before a U.S. House subcommittee on this issue.

Coates directly sampled the dust plumes formed behind tillage implements between 1991 and 1995 at the UA's Yuma Valley Agricultural Center. "We set up monitors and sucked the dust onto filters and then weighed the dust collected on them," he explains. "We measured all the operations, from standing cotton stalks until planting." The measuring apparatus was a grid of 16 openings connected by tubes to the air samplers; it took a sub-sample of the dust plume.

The goal was to provide improved data to document more accurately the dust contribution from agricultural tillage operations. Coates believes farmers should not be penalized for something they haven't done. "They're responsible for part of the problem but not all of it," he maintains. "Forty percent at Yuma is ridiculous."

In addition to meeting NAAQ standards, minimum tillage has other payoffs for growers.

W. Coates

Flail shredder with dust measurement device.

"The farmers' minimum tillage will not only reduce dust emissions and the time spent in the field, but it will also reduce costs," Coates points out. "There is an energy savings there in fuel dollars." Tests run on the UA Marana Agricultural Center over a five year period have shown that reduced tillage does not produce more soil compaction.

Not all of the tillage systems performed equally well in the study. The number and type of operations made a difference. Coates found that the USM implement and and puller produced the fewest emissions. "The Sundance uprooter produced the greatest emissions, while the emissions from riplisting, shredding and mulching were not significantly different from one another," he states. Overall the best system was the puller, followed by the USM.

During the 1998 session, the Arizona Legislature passed a law creating a task force to set up best management practices (BMPs) for field operations to help reduce dust in the air. Coates believes his research will contribute to reasonable standards growers can aim for in carrying out these BMPs. To further his work, he has received a three-year Sustainable Agricultural Research and Education (SARE) grant to conduct more measurements at different sites in Arizona.

— Susan McGinley

W. Coates

The Issue

Dust produced through tillage operations can result in lost topsoil, reduced visibility, hazards for equipment operators and reduced air quality. Growers would like to reduce dust emissions from farm practices, and in the past decade several tillage implements have been developed to deal with the problem. The idea is to cut through the soil in a way that mechanically raises less dust, and also to cut down on the number of passes the tractor needs to take across a field to prepare it for the subsequent crop.

The Clean Air Act authorized the creation of the National Ambient Air Quality Standards (NAAQS) in 1970. These regulations, designed to protect public health, specify the size and amount of dust particulates that are permissible in different areas of the United States. The regulations apply to suspended particulates less than ten microns in diameter. Areas that violate these standards must develop plans to reduce emissions.