National Phosphorus Runoff Project: Virginia

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NRCS

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Objective: Determine the Relationship Between Soil Test Phosphorus and The Concentration of Phosphorus in Surface Runoff From Virginia Soils

Relationships between soil test phosphorus (P) and runoff phosphorus losses from soils in the Shenandoah Valley are being studied using small plots and a portable rainfall simulator (Miller, 1987). Runoff phosphorus levels will be related with various soil test procedures to evaluate or develop soil test procedures for predicting potential surface runoff losses of phosphorus from agricultural soils of the Shenandoah Valley of Virginia.

The experimental procedures that are being followed to evaluate soil test phosphorus (STP) and runoff phosphorus relationships were developed and standardized as part of a national phosphorus runoff project (Sharpley et al., 1999). In this approach 1.5 x 2 m runoff plots are established in fields having STP ranges resulting from fertilizer and manure applied by the land owner in the course of managing his or her land.

This work is being conducted on two NRCS benchmark soils of the Shenandoah Valley of Virginia, concentrating primarily on soils with a history of manure (poultry litter and/or dairy manure) applications. According to the NRCS definition, a benchmark soil is one of large extent within a major land resource area, one that holds a key position in the soil classification system, one for which there is a large amount of data, or one that has special significance to farming, engineering, forestry, ranching, recreational development, urban development, wetland restoration, or other uses (http://statlab.iastate.edu/soils/nssh/630.htm). A benchmark soil is selected because it can represent other soils. Knowledge of the properties and behavior of benchmark soils can be applied to the understanding and interpretation of other soils with similar properties. The primary soil of study is the Frederick series, which is a major agricultural soil in the Shenandoah Valley of Virginia. The second soil is the Christian series, which is commonly found in Augusta County.

Simulated rainfall events are being conducted at an intensity of 2.5-inches/hour. The 2.5-inches/hour intensity is intended to permit comparisons between various states. At selected sites, runoff samples of approximately 1-L volume are collected at 5-min intervals during the runoff event after the start of continuous runoff (six discrete samples/plot/rain), giving a total runoff time of 30 minutes. At all sites, runoff is collected/determined *in toto*. Sample volumes and the corresponding times required to collect them are recorded to calculate the mean runoff flow rates and total runoff volumes. Data are collected at each field site using three simulated runoff events. For a given site, simulated runoff events are conducted with a time interval of 24 to 48 hours between each simulation. Runoff samples are analyzed for total P, dissolved/soluble reactive phosphorus and bioavailable phosphorus (APHA, 1992; Pierzynski, 2000).

Immediately before simulated rain applications, soil samples are collected from outside (adjacent to) the plot to avoid disturbance of the experimental plots. An additional set of samples is collected from the plots after the simulated rain events. Soil samples are collected from the top 0-2 and 0-6 inches of the soil. All samples are analyzed for Mehlich III (Mehlich, 1984), Bray-Kurtz P1 (Bray and Kurtz, 1945), Mehlich 1 (Mehlich, 1953), Fe oxide-impregnated paper strip (Sharpley, 1993), distilled water (Pote et al., 1996), and ammonium oxalate (Sheldrick, 1984; Pote et al., 1996) extractable P. In addition, the samples are analyzed for soil organic matter and pH.

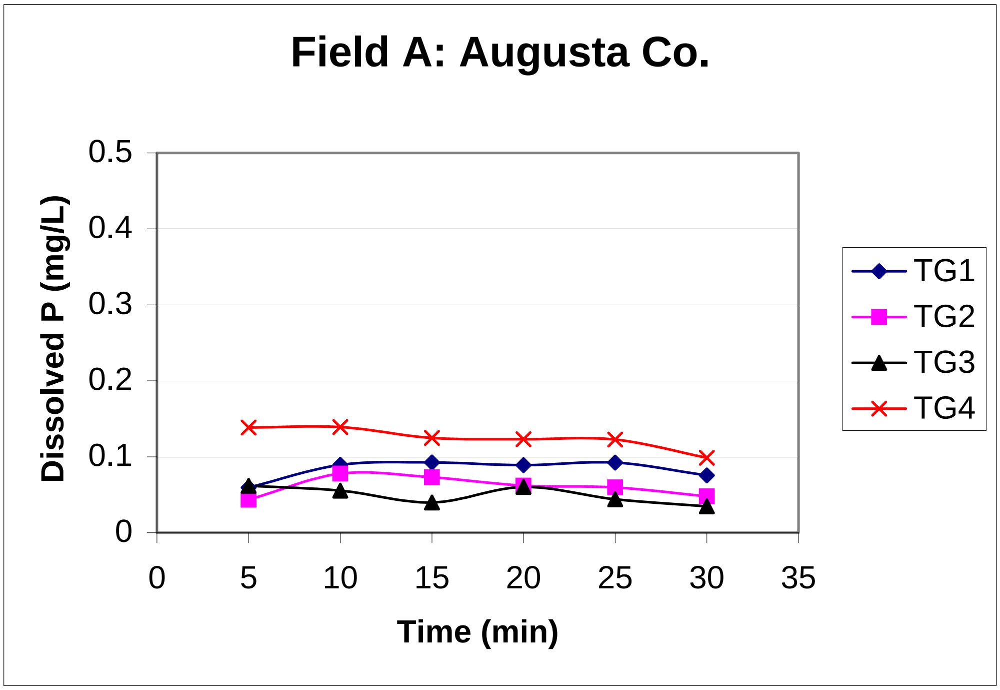
Once the relationship between soil test phosphorus and surface runoff phosphorus concentrations has been established for these soils, evaluating the effects of various best management practices for reducing phosphorus runoff losses can expand this work. Field data will be collected at each location to evaluate the application of a Phosphorus Indexing tool (Lemunyon and Gilbert, 1993; USDA-SCS, 1994; Sims and Leytem, 1999; Gburek et al., 2000) to Virginia soils. Version 1.0 of Virginia's P-Index was released for field testing in Oct. 2001. Calculation of a P Index for each site will allow us to correlate the numerical P Index values with the runoff phosphorus concentrations. These analyses will help in the evaluation/development of a P Index for Virginia Soils.

Current Progress:

Runoff data were collected from six fields in the Shenandoah Valley in the fall of 2000 and one additional field in the spring of 2001. Except for two fields that were planted to forage millet and another field planted to soybeans, runoff data were collected from fields after the harvest of corn for grain or silage. All fields were in the Frederick and Christian soil series and runoff was collected from areas having a slope of 5 to 10%. We are in the process of analyzing the runoff and soil samples collected as part of this project.

Runoff data that we have summarized to date are presented in Figs. 1-3. Data in Fig. 1 shows how the concentration of dissolved inorganic phosphorus in surface runoff varied as a function of time for the 30-minute runoff period for two fields. Phosphorus concentrations in solution did not vary greatly with time during the runoff event for the two fields. Runoff data from individual fields are combined with to evaluate the relationship between phosphorus concentrations in surface runoff and the level of soil test phosphorus based on the Virginia Tech Soil Testing Laboratory (Figs. 2-3). Regression models in Figs. 2-3 shows that for the combined data set, runoff phosphorus concentrations increased as the level of soil test phosphorus increased. A better fit of the data using simple regression was obtained for the second, third and average runoff data sets as compared to the first simulated rainfall event. The final version of the regression model developed from the data presented in Fig. 2 will be incorporated into Virginia's Phosphorus Index to account for the relative risk of phosphorus losses on soils of varying levels of soil test phosphorus. In addition, the data set generated from soils of the Shenandoah Valley will be incorporated into a national database that will be maintained by the Natural Resources and Conservation Service.

During the fall of 2001, runoff data have been collected from seven additional fields in the Shenandoah Valley. This project should be completed by the end of 2002.



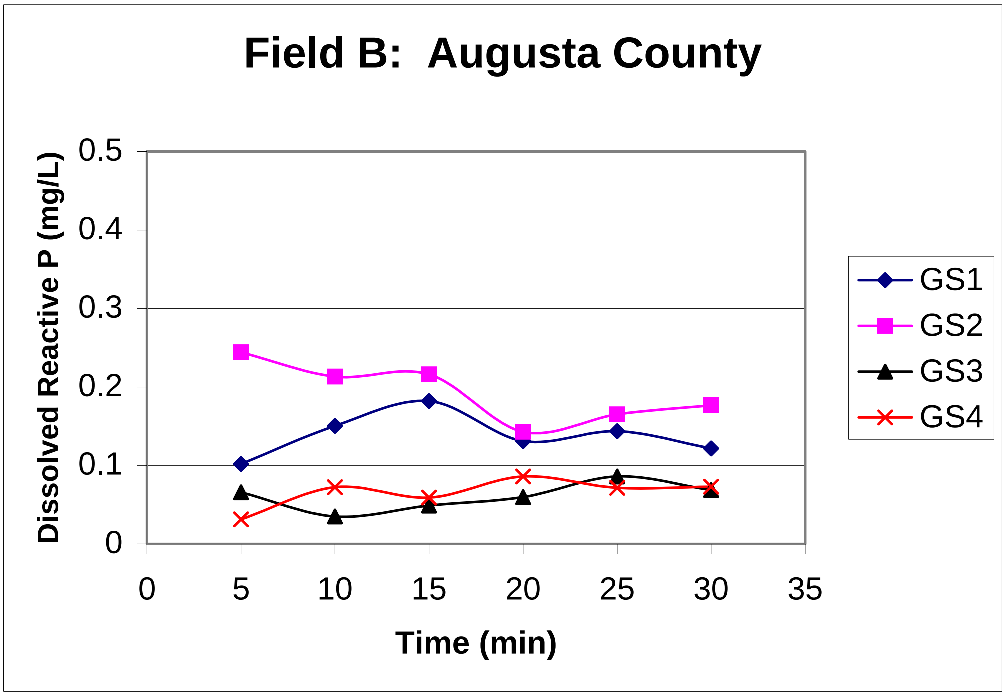


Fig. 1. Concentration of dissolved reactive phosphorus (i.e. inorganic orthophosphate) in surface runoff as a function of time for a 30-minute runoff event determined using portable rainfall simulators. Both sites were in producer fields in Augusta County Virginia. (mg/L = parts per million in solution).

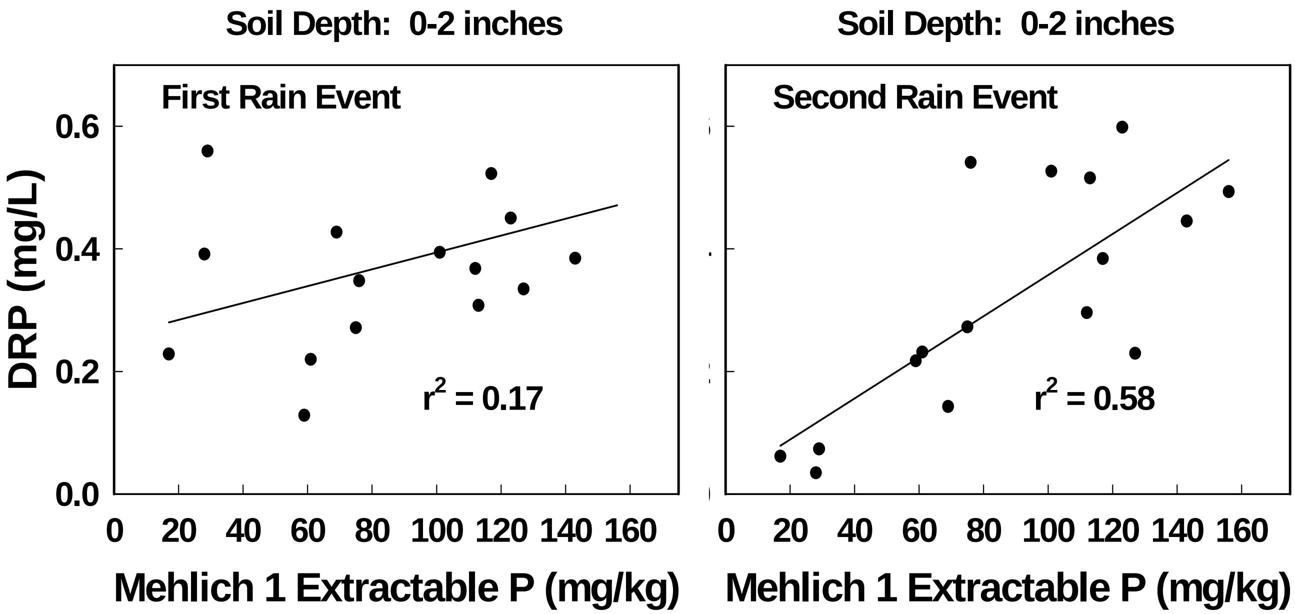


Fig. 2. **Relationship between the concentration of dissolved phosphorus (P) in surface runoff and the level of soil test phosphorus as determined by the Virginia Tech Soil Testing Laboratory. The fields were located in Augusta County and Rockingham County. Data presented are for runoff samples collected after the first and second simulated rainfall events. (mg/L = parts per million in solution).**

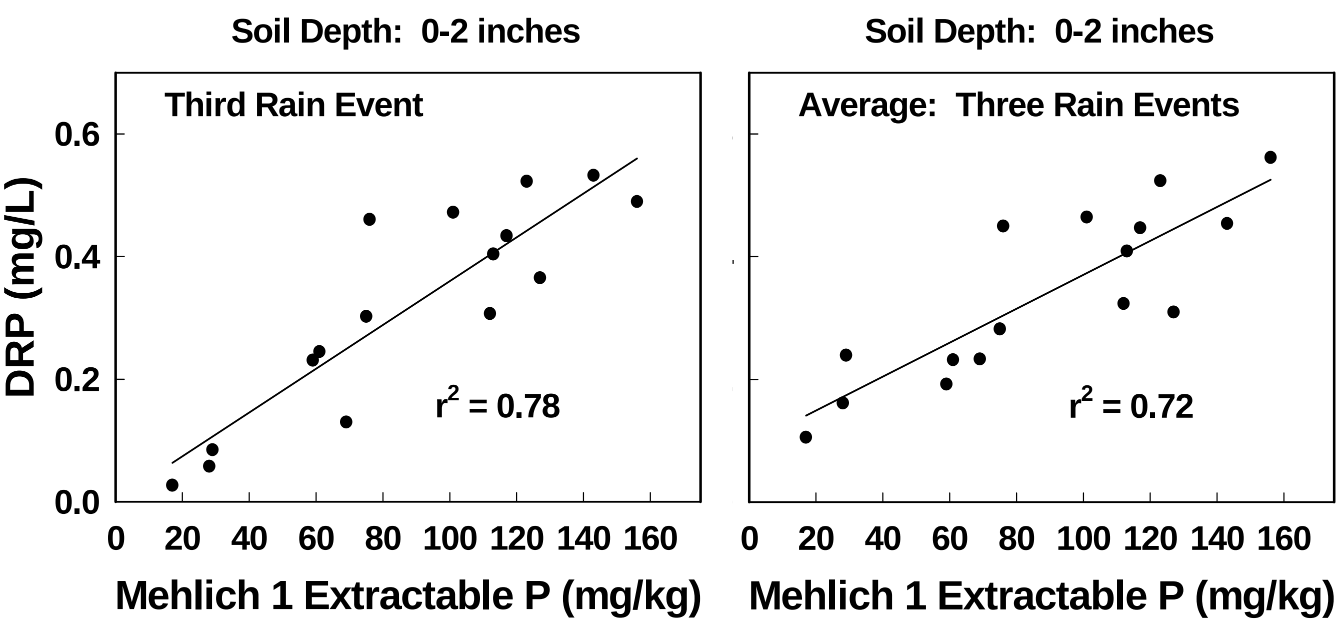


Fig. 3. **Relationship between the concentration of dissolved phosphorus (P) in surface runoff and the level of soil test phosphorus as determined by the Virginia Tech Soil Testing Laboratory. The fields were located in Augusta County and Rockingham County. Data presented are for runoff samples collected after the third simulated rainfall event and the average of all three events. (mg/L = parts per million in solution).**

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