CALIBRATION OF THE ROOT ZONE WATER QUALITY MODEL FOR SIMULATING NITRATE AND PESTICIDE LOSS IN COTTON PRODUCTION SYSTEMS IN THE SOUTHERN PIEDMONT OF GEORGIA

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RESEARCH QUESTION

In Georgia, as cotton production increases and broiler litter continues to become a viable alternative to commercial fertilizer due to its availability and organic nature, we must learn how the nutrients in broiler litter might affect ground- and surface-water quality in cotton production areas. Similarly, there is a need to understand how pesticides used in production agriculture affect water quality. A study was established at the USDA-ARS, Watkinsville, Georgia in 1996 to look at the effects of no-till versus conventional-till management practices and broiler litter versus conventionally-fertilized treatments on nitrate and pesticide losses from cotton in the Southern Piedmont. In order to extrapolate the findings of the study, we chose to calibrate and test the Root Zone Water Quality Model (RZWQM98) to simulate these losses.

LITERATURE SUMMARY

Several models are available to predict nutrient and pesticide losses in agricultural production systems. Many of these models do not incorporate all aspects of the system being modeled. Environmental parameters such as management history of the site, micro-organism and nutrient pool establishment, or well-developed equations for drainage or evapotranspiration are neglected. Some of these models have been tested at the proposed study site in Watkinsville and were not able to accurately predict drainage or nutrient losses from the system.

The Root Zone Water Quality model has been developed over the past ten years by USDA-ARS scientists at the Great Plains System Research unit in Ft. Collins, Colorado. RZWQM98 is a process-based model that simulates major physical, chemical and biological processes in crop production systems under a range of common management practices. It includes simulation of a tile drainage system and runoff as well as predictions of the potential for ground- and surface-water contamination. RZWQM98 also includes options for various degrees of crop parameterization for any crop, and well-developed equations for water movement through the plant-soil-water continuum, an essential part of a model's ability to accurately predict nutrient and pesticide losses.

MATERIALS AND METHODS

In order to accurately simulate a field production system for nitrate and pesticide losses, a model must first be able to accurately simulate soil water dynamics, nitrogen transformation, and plant production for a given soil and climatic environment. We have 15 years of data on cropping practices and management history as well as hydrology, climate, and soil physical characteristics collected from the study area prior to the cotton study begun in 1995. This will allow us to set up and calibrate the model for soil water dynamics, decomposition cycles and plant production capabilities. The plant growth option of the RZWQM98 will be calibrated using one year of cotton production data from a field adjacent to the study site under similar soil and management practices in 1997. This will insure that the parameters used in the production component can accurately simulate cotton growth. This will be the first time the model is calibrated and used to simulate cotton. The water balance and nutrient-cycling portions of the model will be calibrated based on data collected from the cotton study site from 1991 to 1994 including drainage, runoff, and soil moisture as well as measured nitrates in drainage and runoff, amount of residue in no-till treatments, etc. and from values in the literature regarding microbial populations and organic carbon pools in the soil.

RZWQM98 requires fairly extensive initial parameterization. However, with its comprehensive user interface and on-line scientific as well as software-specific help utility, the model can be set up with little or no more effort than models that require simpler and less detailed input. After calibration, the model should represent a starting point very similar to field conditions for the cotton study we will test for nutrient and pesticide losses using runoff, drainage from drain tiles 90 cm below the surface, and soil samples from each treatment plot analyzed for

nitrate and pesticide content from 1996 to 1999.

APPLIED QUESTIONS

1. Will the RZWQM98 accurately predict leaching of nitrates and potential contamination of surface and ground-water water resources from cotton produced under no-till versus conventional-till and broiler litter versus conventionally fertilized treatments?

A calibrated model that can accurately predict losses of nutrients, especially nitrate, to groundwater as well as to rivers, lakes and streams from fields in production agriculture would give us a tool to test various management scenarios for cotton and other crops while working to maintain the quality of our soil and water resources. The amount of broiler litter that needs to be utilized is increasing every year in Georgia. Nitrate in groundwater must be maintained below maximum levels established by the US Environmental Protection Agency as we continue to use litter as a fertilizer on crops and pastures.

2. Will the RZWQM98 accurately predict contamination of surface and ground-water resources from pesticides in cotton produced under these same treatments?

Potential contamination from pesticides commonly used in cropping systems is as important as potential contamination from nutrients. Although pesticides are currently being developed that are more organic in nature and less harmful to the environment, we still rely on chemical pesticides for now to maintain healthy crops and high yields. A model that can accurately predict pesticide movement and loss in a cropping system can be used as a tool to predict types and amounts of potential contaminants to our soil and water. It would also help us to understand how pesticides currently affect these resources and find ways to avoid problems in the future.