

Effectiveness of water and nutrient BMPs to meet regulatory requirements for commercial strawberry production in Florida, USA

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Abstract

Current US federal regulations require individual states to identify impaired water bodies and establish total maximum daily loads (TMDLs) for pollutants entering these water bodies. TMDLs establish the maximum amount of pollutants that can be discharged to a water body and still meet designated uses such as swimming, fishing, or as a potable water use. Florida regulations require identification, verification and adoption by law the best management practices (BMPs) for agricultural non-point sources for large number of crops grown in Florida. The objective of this project was to evaluate the effectiveness of currently-used water and nutrient BMPs for winter strawberry production in Florida to achieve TMDL regulatory limits. The ultimate goal of the project was to provide evidence as to which current BMPs are effective and encourage farmers to adopt water and nutrient management practices that reduce contamination to shallow groundwater, surface runoff and surface water bodies. Results from 4 years of monitoring showed that consistently, for the most part, current BMPs used are very effective in managing nutrient losses. This study was used to establish criteria for accepted BMPs that would qualify strawberry growers for presumed compliance status, exempting them from regulatory penalties for exceeding TMDL limits.

Key Words

Drip irrigation, nutrient loss, groundwater contamination.

Introduction

Florida's Nonpoint Source Management Program was established in 1978 and has undergone numerous changes over the years. The program requires the use of structural and nonstructural BMPs to minimize nonpoint source pollution, either through traditional regulation (i.e., Environmental Resource Permits) or through voluntary measures (i.e., implementation of BMPs). Section 303(d) of the FCWA also requires states to identify impaired water bodies and establish total maximum daily loads (TMDLs) for pollutants entering these water bodies. TMDLs establish the maximum amount of pollutants that can be discharged to a water body and still have it meet designated uses such as swimming, fishing, or as a potable water use. Once a TMDL is set, an implementation plan must be developed that specifies the activities that watershed landowners will undertake to reduce point and nonpoint source pollutant loadings. Many of the 44,000 commercial farmers who produce food, fiber, and livestock on approximately 10 million acres in Florida will be required to meet specific water quality load allocations. Water quality targets will be achieved through a combination of regulatory, non-regulatory, and incentive-based measures.

To address TMDLs, the Florida legislature passed the 1999 Florida Watershed Restoration Act that gives the Florida Department of Agriculture and Consumer Services (FDACS) the authority to develop interim measures, BMPs, cost-share incentives, and other technical assistance programs to assist agriculture in reducing pollutant loads in target watersheds. This law defines a process for the development of TMDLs for impaired waters as required by section 303(d) of the Federal Clean Water Act. It directs the FDACS to identify and adopt by rule BMPs for agricultural nonpoint sources. The Florida Department of Environmental Protection (FDEP) must also verify that these BMPs are effective at reducing pollutant loading to these waters. By law, agricultural producers who voluntarily implement these BMPs, which have been verified effective and adopted by rule, will receive a presumption of compliance with state water quality standards. They will also be eligible for cost-share money to implement selected BMPs once eligible practices are identified. The objectives of this study were: 1) To assess, for the various crop production scenarios, nutrient load potential of nitrogen from subsurface leaching and surface runoff; 2) to assist growers in adopting water and fertilizer management technologies that will reduce the amount of fertilizer nutrients (with emphasis on nitrogen) leaching each year from typical crop production systems; and 3) to assist growers in utilizing state-of-the-art, often computer-based, on-farm decision-making packages to best manage their fertilizer inputs for minimization of groundwater and surface water contamination.

Methods

This 4-year project was conducted on 11 commercial grower/cooperator operation sites. These locations represented 14 different soil types. Leachate samples were collected weekly to determine the volume and NO₃-N-concentration in leachate that had moved beyond the root zone. A passive wick-type leachate collector using fiberglass rope was constructed of PVC and installed in a plant bed, directly below a drip irrigation emitter, below the rooting zone (~ 45 cm below the top of the bed). There were 21 sampling sites consisting of 8 leachate samplers (replicates) per site. Samples were analyzed using an Alpkem Rapid Flow Analyzer (Model RFA/2). Weekly samples were used to determine cumulative NO₃-N losses for each site and were compared to soil type and grower practices to determine if any relationships were evident. Samples were collected from Nov to May (2004-2008).

Strawberry production in central Florida used methyl bromide fumigated raised-bed culture with black plastic mulch (Olsen and Simonne 2008). Bare-root transplants were set during the month of October (35,000 plants /ha, double rows 60 cm apart, 38 cm in row spacing) and established with overhead irrigation. All water and nutrient management decisions were made by the grower/cooperator. Harvests were made as needed until grower determined that market conditions warranted ending the production season (late March or early April). Cultural information was solicited from each grower to determine irrigation and fertilizer application scheduling, microirrigation tube type, emitter spacing and application rates, seasonal liquid and dry fertilization rates, and other information.

Results

Individual grower cultural information was evaluated and resulted in the following: 1) all growers used drip irrigation to provide water and nutrients for crop growth; 2) drip tube emission rates were from 3 to 6 l/min per 100 m of bed; 3) daily irrigation application rates ranged from 0.3 to 0.6 cm/day depending stage of season; 4) approximately 50% of the growers used a preplant dry fertilizer application (31 kg N /ha average) and 50% used no preplant fertilizer; 5) average liquid fertilizer application amounts ranged from 0.56 kg to 4 kg N /ha/day depending on crop stage (seasonal average of 1.2 kg N /ha/day). This information revealed that participants in the study were applying on average 180 kg N /ha for the season. The recommended seasonal rate was 150 kg /ha (Olsen and Simonne 2008). The majority of sites showed seasonal cumulative nitrate-N leaching was < 5kg /ha (Figure 1). Overall, there was little seasonal variability of nitrate-N leached from each site at each farm. Individual farm irrigation and nutrient management likely influenced the overall leached N when compared to other farms. Figure 2 shows the average seasonal cumulative leaching for each year, with all sites on all farms combined. Differences among seasons were always less than 0.5 lbs of N at any time, indicating the repeatability of the results from year to year.

Considerable variability that can be experienced when conducting such a study on commercial production fields is common, but the results from this study were remarkably consistent from year to year. However, when one considers the BMPs that strawberry producers are currently implementing, the results should not be surprising. All of the growers in this study (and up to 95% of the industry) use drip irrigation as the means of providing water and nutrients to the crop. Strawberries are very prone to salt damage, therefore producers accepted microirrigation many years ago primarily because of its ability to provide liquid fertilizer when and where is it needed. The water conservation advantages of microirrigation were secondary. Since accumulated fertilizer salts should to be avoided, producers are careful not to over-apply N, and since irrigation management goes hand-in-hand with nutrient management, care was taken to not to leach the applied nutrients below the root zone.

In conclusion, for the cooperators that were participating in this study, current strawberry production practices appear to be adequate for managing nitrate-N losses from production fields. We assume that this will be true for other growers using similar management practices. This study was also important for increasing grower participation in Florida's voluntary BMP participation program.

References

Olson SM, Simonne E (2005) 'Vegetable Production Handbook for Florida'. (Vance Pub.: Lenexa, KS).

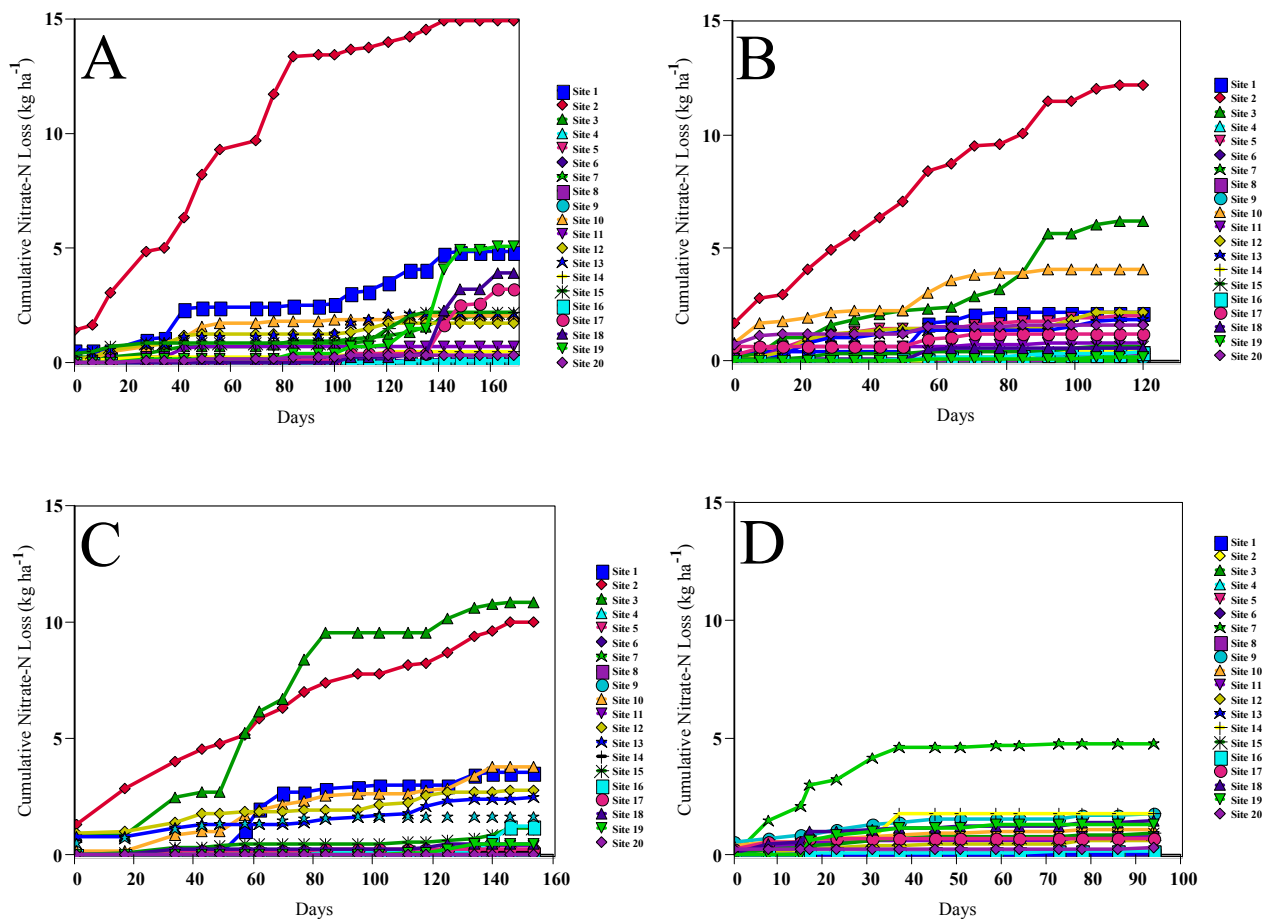


Figure 1. Mean cumulative nitrate-N leaching losses for each sampling site for A) 2004-05; B) 2005-06; C) 2006-07; and D) 2007-08 production seasons.

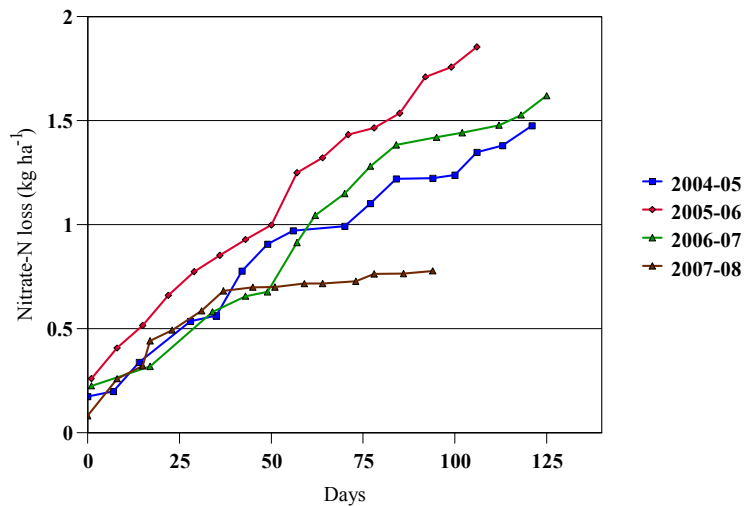


Figure 2. Mean cumulative nitrate-N leaching losses for all sites combined for each production season.