Evaluation of Best Management Practices to Protect Surface Water from Pesticides and Fertilizer Applied to Bermudagrass Fairways

Dr. James H. Baird

Michigan State University

Goals:

- *Evaluate the use of buffers as a best management practice to reduce surface runoff of pesticides and nutrients from golf course fairways and other turf areas*

- *Determine the surface runoff characteristics of 2,4-D, mecoprop, dicamba, chlorpyrifos, nitrogen, and phosphorus applied to bermudagrass turf*

Cooperators:

Nicholas Basta
Raymond Huhnke
Gordon Johnson
Daniel Storm
Mark Payton
Daniel Storm
Craig Wilson
Ellen Stevens
Michael Smolen
Dennis Martin

Oklahoma State University

The potential for runoff of pesticides and nutrients from turf, especially on golf courses, is the subject of increasing environmental concern. As a result, a project was initiated in 1995 under the joint sponsorship of the United States Golf Association and the Oklahoma Agricultural Experiment Station. The primary objective was to evaluate the use of buffers as a best management practice for reducing pesticide and nutrient runoff from golf courses and other turf areas.

Studies were conducted in 1995 and 1996 on a three-acre sloped field in bermudagrass [*Cynodon dactylon* (L.) Pers.] located at the Oklahoma State University Agronomy in Stillwater, OK. The soil is a Kirkland silt loam. The area was surveyed to determine suitable locations for eight rainfall simulator set-ups, each containing four plots. The average slope of the plots was 6%. A portable rainfall simulator was used to apply controlled precipitation to a 50-ft diameter area containing the four plots (6 ft wide by 32 ft long). Each area of the plot receiving pesticide and fertilizer was 6 by 16 ft and mowed at 0.5 in to represent a golf course fairway. The buffer area was considered to represent a golf course rough or the area between the treated area (fairway) and

collection point (surface water). The following fertilizers and pesticides were applied to the treated area: N at 1.0 lb ai 1000 ft^{-2} from urea (46% N) or S-coated urea (39% N); P at 1.0 lb ai 1000 ft^{-2} from triple superphosphate (20% P); chlorpyrifos (0.5% granular or 50% wettable powder) at 2.0 lb ai A^{-1}; and 2,4-D at 1.0 lb ai A^{-1}, mecoprop at 0.5 lb ai A^{-1}, and dicamba at 0.1 lb ai A^{-1} formulated as dimethylamine salts. In most experiments, simulated rainfall (2.5 in h^{-1}) was applied for 75 min within 24 h following application of chemicals. Start of surface runoff was recorded when a continuous trickle of water was first observed at the collection pit. Samples were collected at preset times after the start of runoff for individual plots using a nominal sampling schedule. Most plots were sampled 10 times during the simulated rainfall period. In most experiments, a single volume-weighted composite was prepared for chemical analysis from runoff samples for each plot.

In 1995, buffer length (0, 8, and 16 ft), mowing height (0.5 and 1.5 in), and solid-tine aerification were evaluated to reduce pesticide and nutrient runoff. Soil moisture before simulated rainfall in July 1995 was low and pesticide and nutrient loss to surface runoff was <3% and 2% of applied, respectively. Highest concentrations of pesticides and nutrients in runoff water were 314 ppb for 2,4-D and 9.57 ppm for PO$_4$-P from the treatment containing no buffer. In August 1995, 6.5 in of natural rainfall fell 7 d before simulated rainfall and pesticide and nutrient loss to surface runoff was increased to 15 and 10% of applied, respectively. Highest concentrations of pesticides and nutrients in runoff water were 174 ppb for 2,4-D and 8.14 ppm for PO$_4$-P from the treatment containing no buffer. Overall, buffers were effective in reducing pesticide and nutrient runoff due in part to dilution. In most instances, buffer mowing height, length (8 vs. 16 ft), and aerification did not significantly affect pesticide and nutrient runoff. A paper describing research conducted in 1995 is published in the *Journal of Environmental Quality* Vol. 26 (1997).

In 1996, a portable rainfall simulator was used to evaluate the effects of: 1) buffer length (0, 4, 8, and 16 ft) at a 1.5 in mowing height; and 2) mowing height (0.5, 1.5, and 3.0 in) over a 16-ft long buffer on pesticide and nutrient runoff from bermudagrass turf. In the length experiment, buffers reduced surface runoff losses of the pesticides and PO$_4$-P compared to no buffer. No differences in surface runoff were observed between buffer lengths of 4 and 8 ft. In the mowing height experiment, the buffer mowed at 3.0 in was most effective in reducing surface runoff of pesticides and nutrients. No differences in surface runoff were observed between buffers mowed at 0.5 and 1.5 in. Overall, effectiveness of buffers was dependent upon soil moisture content prior to simulated rainfall.

In 1995 and 1996, estimated concentrations of each contaminant for each plot were computed from a single volume-weighted composite of samples taken in time series throughout the course of a simulated rainfall event. The focus of an ancillary investigation in 1996 was the manner in which buffers affect contaminant transport over the course of the simulation. For this purpose, samples taken in time series from no-buffer and 16-ft buffer treatments were individually analyzed for pesticide and nutrient content. Significant ratios for 2,4-D ranged from 2079 times higher for non-buffered

plots at 15 min to 3 times larger at 40 min (see Figure ##). Overall, the buffer was found to reduce and delay the onset of 2,4-D concentration in runoff, with a peak contamination of 41 ppb occurring approximately 51 min after the start of rainfall, according to the fitted model. Similar results were found for other pesticides and nutrients. For the conditions studied, significant ratios over the first half of the experiment suggest that the buffer takes an even more important role in reducing contaminant transport when rain events are expected to be shorter than 40 min. Analyses of estimated total runoff loss were not conclusive but suggested an effect of the buffer on runoff quality.

In addition to evaluating the effects of buffers on surface runoff of chemicals from turf, the time series data were used to evaluate the effectiveness of surface runoff sampling techniques for rainfall simulation studies. Volume-weighted composite samples are useful for determining if a management practice (e.g., buffer) affects the runoff quantity or quality. The data were used to predict the volume-weighted concentration of pesticides and nutrients in the surface runoff for samples taken at various times after the start of runoff. For the conditions studied, it was found that the difference in volume-weighted concentration between buffered and non-buffered plots had the lowest statistical significance 15 to 25 min after start of runoff, so sampling 40 to 50 min after start of runoff is recommended. Time series data is desirable for predicting off-site environmental impacts from pesticides and nutrients in surface runoff. An optimal sampling scheme requires the smallest number of chemical analyses while still representing the actual time series accurately. For the data analyzed, the sampled data best represented the actual time series when sampling intervals were shorter at the start of runoff. The two schemes that worked best were: 1) sample every 2 min for the first 10 min after runoff and every 10 min thereafter; or 2) sample at 0, 2.5, 5, 10 min and every 10 min thereafter. The 2 to 10 min scheme was more accurate, but requires two additional samples. Which scheme to select depends on the economics and objective of the study.

Based upon this investigation, chemical losses in surface runoff from turf can be reduced by the following: 1) install buffers between surface water and areas treated with chemicals; 2) effective buffer length is dependent upon site conditions (longer buffers are safer); 3) a 3-in buffer mowing height is more effective than 0.5 or 1.5 in.; 4) avoid chemical application following heavy irrigation or rainfall events; and 5) choose pesticides and nutrients with low runoff potential. More information about this project can be found at the internet address: http://hydro1.agen.okstate.edu.
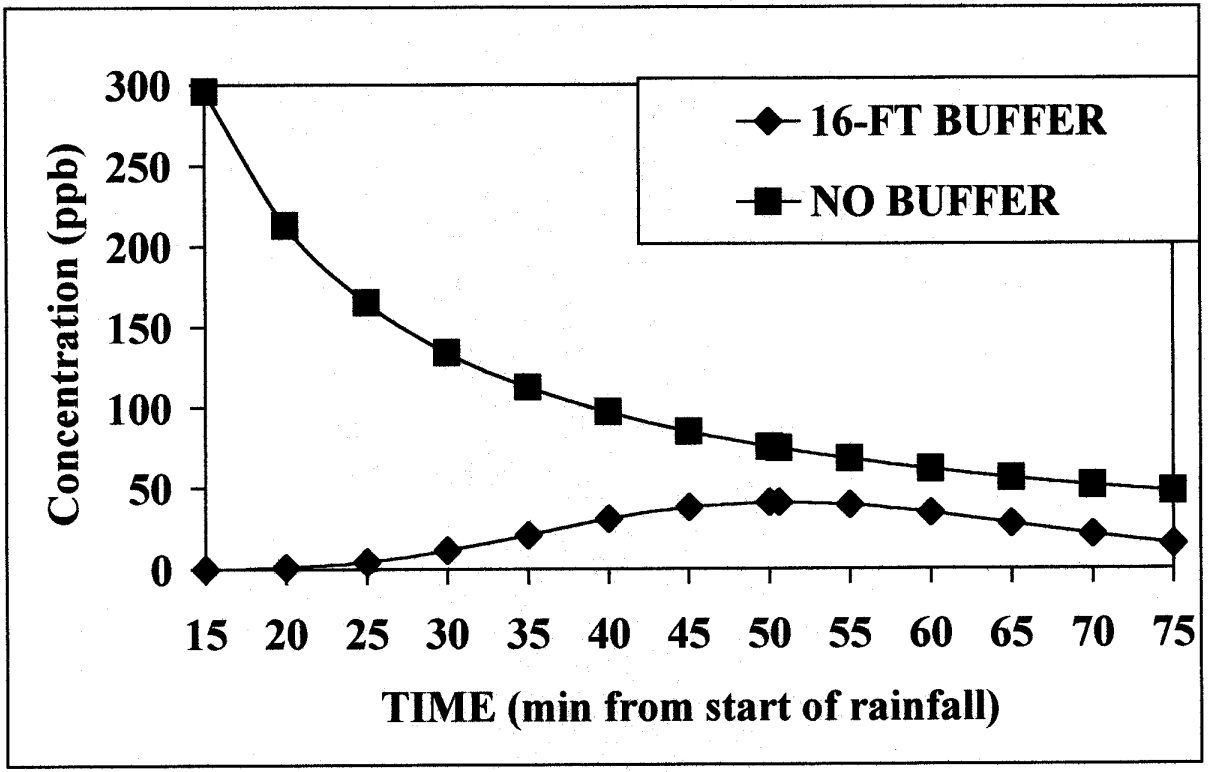
Figure ##. Plot of the predicted concentration of 2,4-D in surface runoff versus time in the 1996 buffer length experiment. *, ** Significant at alpha levels 0.05 and 0.01, respectively.