

Correlation of Bensulfuron Methyl and Dye Concentrations in Water Following Concurrent Application

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INTRODUCTION

Residue dissipation studies must be conducted in the field as part of the US Environmental Protection Agency (EPA) registration requirements for an aquatic herbicide. If water movement characteristics within a lake are not known, water samples for residue analysis must be collected over a long period of time, from a large number of sampling stations, within and outside the treatment plot to determine the fate of the herbicide. Such pre-determined sampling regimes can result in large numbers of samples being collected and analyzed (at considerable cost) that do not contain residues. The ability to characterize water movement within a plot would aid in determining why some samples yielded residues and others did not.

Several concurrent applications of the red fluorescent dye rhodamine WT and the herbicides fluridone (1-methyl-3-phenyl-5-[3-(trifluoromethyl) phenyl] 4(1*H*)-pyridinone) or endothall (dipotassium salt of 7-oxabicyclo[2,2,1]heptane-2,3- dicarboxylic acid) have been made in moving water (Fox et al. 1991b, Fox and Haller 1990). The significant correlations between dye and herbicide residue concentrations found in these studies showed that by tracking the dye in and around the treatment plots, more efficient herbicide residue sampling could be achieved than by using pre-determined sampling times and places.

As part of the aquatic registration requirements for bensulfuron methyl (methyl 2-[[[[[(4,6 dimethoxy pyrimidin-2-yl) amino] carbonyl] amino] sulfonyl] methyl] benzoate), concurrent applications of rhodamine WT were made with the herbicide in Lake Seminole, GA. The purpose of these dye applications was to provide information about water movement in the treated areas, to relate time/dose relationships with plant control, and to establish whether dye concentrations could be used to predict residues of bensulfuron methyl. The results of the latter objective are described here.

MATERIALS AND METHODS

On May 18, 1989 three 4-ha plots in Lake Seminole, GA, were treated under an EPA Experimental Use Permit

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(EUP) with sufficient herbicide to achieve a concentration of 300 µg/l (ppb) of bensulfuron methyl. Sufficient rhodamine WT dye (20% active solution) to provide a concentration of 12.5 µg/l was applied concurrently with the herbicide to two of those plots (plots 1 and 3). The tank mixes were injected from a hand gun mounted vertically on the bow of an airboat.

Within the treatment areas, dye and herbicide residues were sampled from the center of the plot and the centers of each quadrant. Dye was measured from a sampling boat using a continuous-flow field fluorometer as described by Fox et al. (1991a). Water samples for bensulfuron methyl residue analysis were collected from the fluorometer outflow in opaque 1-l polyethylene bottles. Samples and dye readings were collected using a submersible bilge pump from 0.5m above the lake bottom, 0.5m below the water surface and from a composite of the water column mixed in a bucket. Average water depth was 1.9 m. Samples were collected in plot 1 at 2.5 hr after treatment, and in plot 3 at 1.5, 4.2, 7.5, 10.6, 12.7 and 25.1 hr after treatment. Additional herbicide residue samples were collected at each sampling time from outside the plots in areas where dye was found. Immediately after collection the samples were placed in ice and then stored at -15 C until analyzed. Bensulfuron methyl residue analyses were conducted by Morse Laboratories, Inc. using immuno-assay procedures.

Correlations between dye and bensulfuron methyl concentrations were calculated for each treatment. Dissipation half-lives were calculated from composite samples and were compared for dye and herbicide residues in plot 3 using analysis of variance and regression procedures as described by Fox et al. (1991a).

RESULTS AND DISCUSSION

Correlations of dye and bensulfuron methyl concentrations resulting from both applications were significant, with correlation coefficients of $r = 0.99$ (Figure 1). These correlations included samples collected from the top and bottom of the water column, and within and outside the treatment plots. Samples from plot 1 were only collected up to 4 hr after treatment but included samples collected several hundred meters downstream of the plot. The correlation data from plot 3 include samples collected over 25 hr after treatment and over 500 m from the plot.

Movement and dilution of the dye and bensulfuron methyl from plot 1 was too rapid to calculate half-lives for that plot. All residues had disappeared from the southeast

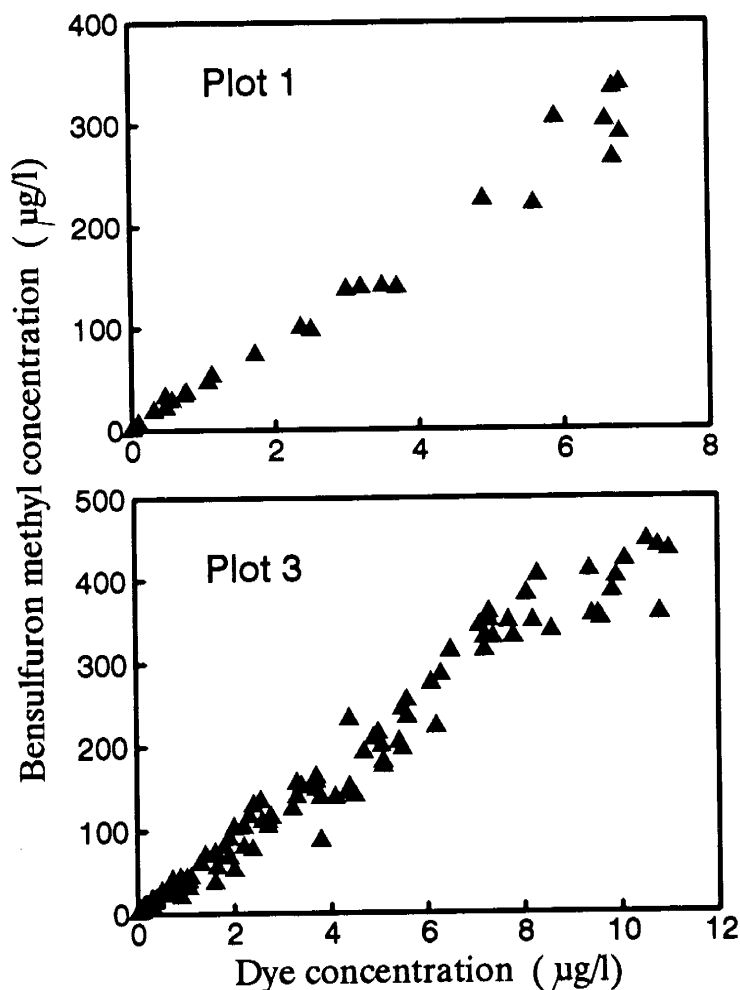


Figure 1. Correlations of rhodamine WT and bensulfuron methyl concentrations from in and around plot 1 (above) and plot 3 (below), each with correlation coefficients of $r = 0.99$.

sampling station in plot 1 by the first sampling time (1.5 hr after treatment) due to water flow and windy conditions. Extensive dye measurements outside the plot were not possible because the water moved into an area of flooded timber, inaccessible to our boats.

Both dye and herbicide residues from plot 3 showed exponential rates of dissipation. There was no significant difference ($P < 0.05$) between the half-lives in plot 3 (4.4

hr for dye and herbicide) with r^2 values of 0.89 and 0.92, respectively.

These data were extremely valuable in providing information on the fate of bensulfuron methyl residues in the treated water in Lake Seminole. Water movement had not been anticipated in these plots on the scale that it occurred. Herbicide residues could have easily been missed in time and space, particularly in plot 1, if the concurrent dye application had not been made and tracked. These data show that for at least up to 24 hr after treatment, bensulfuron methyl residue concentrations in water could be predicted from any dye reading taken in or around the plots. In future studies this would allow extensive predictions of bensulfuron methyl residue movement and dissipation after a concurrent treatment and dye tracking, for the cost of only the few residue analyses needed to calculate the correlation relationship with the dye.

Additional correlations from sites with less water movement need to be calculated to determine the duration over which bensulfuron methyl residues can be accurately tracked using rhodamine WT. However, these data indicate that rhodamine WT may be able to mimic movement of bensulfuron methyl for similar distances and periods of time as were found for other aquatic herbicides.

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