

Bensulfuron Methyl Residues in Florida Lakes¹

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INTRODUCTION

Bensulfuron methyl is used for weed control in rice production and laboratory studies indicate potential use for aquatic plant management (Anderson and Dechoretz 1988, Haller et al. 1992, Langeland and Laroche 1992, Van and Vandiver 1992, Bowmer et al. 1992). It was registered for experimental use as an aquatic herbicide or growth regulator in 1989 (Mariner[®], EPA NO.352-EUP-146).

Application of bensulfuron methyl to three Florida ponds, which averaged 0.50 m in depth, resulted in less than six months control of hydrilla (*Hydrilla verticillata* (L.f.) Royle), and half-lives of bensulfuron methyl ranged between 5.9 and 9.1 days (Langeland and Laroche in press). In contrast, application to four Florida (USA) lakes, which ranged between 2.8 and 5 m in depth, resulted in hydrilla control for up to two years (Langeland 1993). A possible explanation for the greater control observed in the lakes, as compared to shallow ponds, was that hydrilla was subjected to longer exposure to bensulfuron methyl in the lakes compared to the ponds.

The purpose of the study in which up to two years hydrilla control was observed was to determine the response of hydrilla growth and tuber production to application of bensulfuron methyl in operational settings in lakes (Langeland 1993). The purpose of this paper is to report residue data from the study noted above, which were not available at that time, and supports the hypothesis that bensulfuron methyl is more persistent in deep lakes compared to shallow ponds.

MATERIALS AND METHODS

Four lakes were treated with bensulfuron methyl as follows: Johnny's Lake, 2.2 ha with an average depth of 5.0 m, was treated with 25 ppb (all application concentrations are nominal) four times, 46 days between each treatment, from May to October 1990. Catfish Lake, 10.4 ha with an average depth of 3.3 m, was treated with 100 ppb in July 1990. Palmer

Ranch Lake, 3.4 ha with an average depth of 2.8 m, was treated with 25 ppb in August 1990 and with 50 ppb in August 1991. Lake Wastena, 10 ha with an average depth of 3.7 m, was treated with 40 ppb in August 1991. Detailed descriptions of the lakes and applications have been reported (Langeland 1993).

Water samples were collected (0.50 m deep) from the lakes for bensulfuron methyl residue analysis at the following times: two samples from Johnny's Lake 308 days after the final application; a single sample from Catfish Lake 371 days after application; a single sample from Palmer Ranch Lake 348 days after the initial application, and three replicate samples 11, 15, 21, 27, 32, 41, 45, and 237 days after the second application; and three replicate samples from Lake Wastena 1, 5, 10, 15, 31, 55, 110, and 222 days after application. All samples were transported on ice and stored frozen prior to analysis. Bensulfuron methyl analysis was conducted by du Pont Agricultural Products using the immunoassay method of Sharp (1989).

Half-lives of bensulfuron methyl were determined as $t_{1/2} = \ln 2/k$. For Catfish Lake and the initial application to Palmer Ranch Lake, k was determined as $\ln(C_0/C_t) = kt$ where C_0 is the nominal application concentration, C_t is the measured concentration at time t , and t is the interval (days) between bensulfuron methyl application and collection of the water sample from which C_t is derived. For Lake Wastena and the second application to Palmer Ranch Lake, k was determined as the slope of the regression equation in the form $y = e^{-akt}$ where y represents bensulfuron methyl concentration at t days after application, e is the base of the natural logarithm, a is the natural logarithm of the predicted initial concentration, and t is the days after application.

RESULTS AND DISCUSSION

The 46-day duration between applications to Johnny's lake were based on an expected 14-day half-life on bensulfuron methyl, which had been derived from a previous study conducted in a shallow pond (unpublished). Based on this half-life the concentration of bensulfuron methyl should have been less than 2.0 ppb 46 days after the final application and negligible in the sample collected 308 days after. However, two water samples collected from Johnny's Lake 308 days after the final of four 25 ppb applications still contained 2.1 and 2.0 ppb bensulfuronmethyl. Although a half-life of bensulfuron methyl cannot be calculated in this lake because of the sequential nature of the treatments, these concentrations indicate a much longer half-life than the

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maximum of 9.1 days previously measured in shallow ponds in Florida (Langeland and Laroche 1994).

The concentration of bensulfuron methyl in Palmer Ranch Lake 348 days after the initial application was 0.36 ppb. The half-life calculated from the initial nominal concentration of 25 ppb is 58 days. The concentration in Catfish Lake 371 days after application was 0.32 ppb. The half-life calculated from the initial nominal concentration of 100 ppb is 45 days. Half-lives predicted from bensulfuron methyl residues in Palmer Ranch Lake after the second applications and in Lake Wastena were 77 and 41 days respectively (Figure 1).

The relatively longer half-lives of bensulfuron methyl observed in deep lakes of this study are in sharp contrast to shorter half-lives in shallow Florida ponds (Langeland and Laroche 1994) and rice paddies of Louisiana and California (Anderson 1992). These data support the previously suggested hypothesis that bensulfuron methyl persistence can, other conditions being equal, be directly related to water depth (Ackerson undated, Langeland and Laroche 1994). The probable reason for this is that bensulfuron methyl is broken down, predominantly, by microbes near the surface of the hydrosol; and as water depth increases, there are greater amounts of the compound dissolved in the water column compared to the amount in proximity to the hydrosol/water interface, where degradation would occur. While temperature would be expected to influence the rate of microbial breakdown, a seasonal effect was not observed in this study. This is probably because bensulfuron methyl is initially removed from the water by adsorption to sediments, which would not be a temperature dependent phenomenon, followed by microbial breakdown on the sediment surface.

This information supports the hypothesis that greater hydrilla control with bensulfuron methyl observed in deeper lakes (Langeland 1993) compared to shallow ponds (Langeland and Laroche 1994) is a result of longer half-lives and thus longer exposure of the plants to the compound in deep lakes.

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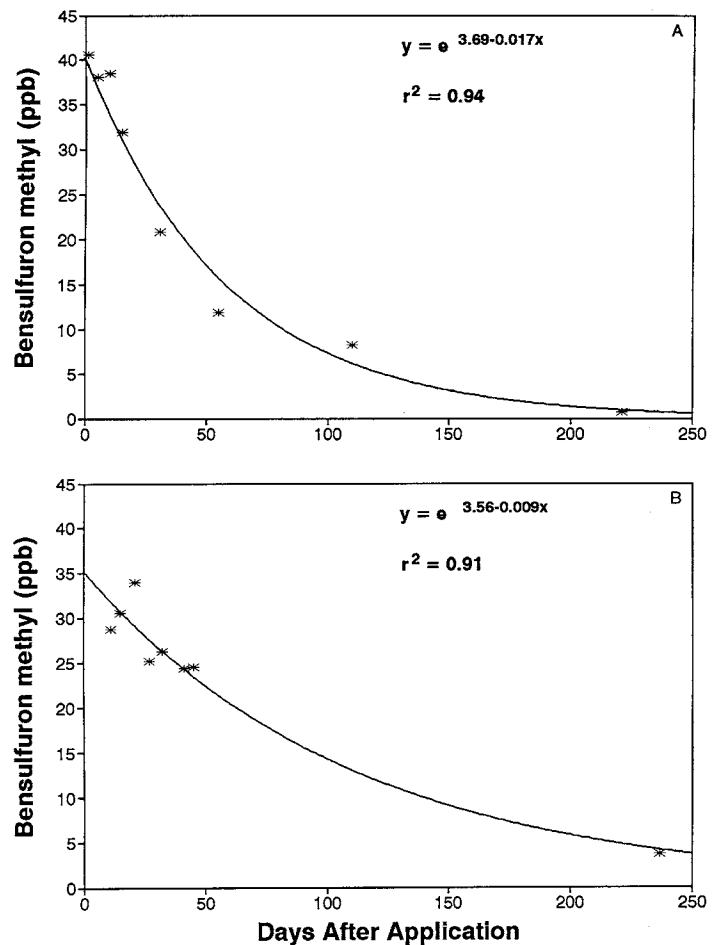


Figure 1. Bensulfuron methyl residues following application to two Florida lakes, Lake Wastena (A) and Palmer Ranch Lake (B). Observed values (*) represent average of three replicate samples.

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