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## RODEO HERBICIDE NOT ACUTELY TOXIC TO AQUATIC INVERTEBRATES IN PRAIRIE POTHOLE WETLANDS

We assessed the effects of an application of a mixture of Rodeo, X-77 Spreader (nonionic surfactant), and Chem-Trol (drift retardant) on the survival of three species of aquatic invertebrates in wetlands. We also determined the relative toxicity of these chemicals to the same aquatic invertebrates in the laboratory. Aerial application of Rodeo, along with a surfactant and a drift retardant, may be effective in creating openings in dense, emergent wetland vegetation for enhancing waterfowl habitat. Rodeo is a commercial formulation of the herbicide glyphosate, which is approved by the U.S. Environmental Protection Agency for aquatic use. The use of a nonionic surfactant is required and a drift retardant is recommended by the manufacturer when Rodeo is applied from the air.

### FIELD AND LABORATORY STUDIES

The survival of caged midge larvae (*Chironomus* spp.), amphipods (*Hyaella azteca*), and leeches (*Nepheleopsis obscura*) was assessed in prairie pothole wetlands treated with a mixture of Rodeo, X-77 Spreader, and Chem-Trol at 46.8 L/ha (within the range of the manufacturer's recommended application rate). The mixture was applied by fixed-wing aircraft to cattail stands in six wetlands in Nelson County, North Dakota, in July 1990. Four additional wetlands were used as reference sites. Survival of invertebrates was measured at 0.5, 1, 2, 4, 8, 16, and 21 days posttreatment. Water samples were collected

before and after treatment from each wetland and analyzed for glyphosate residues. Laboratory acute toxicity tests were also conducted with the same species in a synthetic dilution water that simulated the chemical makeup of the study wetlands. The invertebrates were exposed to different concentrations of each chemical individually and also to mixtures of these chemicals at the field application ratio. Midges were exposed for 48 h and leeches and amphipods for 96 h. The toxic response measured was death, and the measure of acute toxicity was the LC50 (median lethal concentration). The additive index (AI) was used to determine the type of joint toxicity exhibited by the mixture. If the range of AI values overlapped zero, the mixture was judged to be additive in toxicity. Mixtures with a range of AI values greater than zero were considered greater than additive in toxicity (synergistic), and those with a range of AI values less than zero were less than additive in toxicity (antagonistic).

### AERIAL APPLICATION OF RODEO WAS NOT TOXIC TO INVERTEBRATES

An analysis of variance was used to determine treatment differences for field data. Although survival of midges, leeches, and amphipods decreased significantly over time for all species, differences in survival between treated and reference wetlands were not statistically significant (Figure).

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## SURFACTANT WAS MORE TOXIC THAN RODEO

In laboratory tests, X-77 Spreader (LC50's = 5.3–14.1 mg/L) was found to be 86 to 136 times more toxic to invertebrates than Rodeo (LC50's = 720–1,216 mg/L), whereas Rodeo was at least 24 times more toxic than Chem-Trol (Table). Amphipods were more sensitive to X-77 Spreader than were midges and leeches, but all three species were similar in their sensitivity to Rodeo. Chem-Trol was relatively nontoxic to these taxa, and concentrations  $\leq 28,000$  mg/L killed  $\leq 50\%$  of the animals.

The mixture of the three chemicals exhibited additive toxicity to amphipods and midges, and greater than additive toxicity to leeches (Table). Comparison of the toxic units (expressed as the ratio of the LC50 of the chemical in mixture to its individual LC50 value) showed that X-77 Spreader was the major toxic component in the mixture. The toxic contribution of Chem-Trol was insignificant because it was present in the mixture at  $<0.1\%$  of the concentrations that killed  $<50\%$  of the invertebrates tested. On the basis of the LC50 values, the mixture was 3 to 7 times more toxic to aquatic invertebrates than Rodeo tested individually because of the large toxic contribution of X-77 Spreader.

## RODEO FIELD MIXTURE HAS LOW HAZARD POTENTIAL

In order to assess the potential hazard of these chemicals to aquatic invertebrates, concentrations that produce toxic effects are compared to the expected or measured concentrations in the wetlands. The highest concentration of glyphosate found in the treated wetlands was 0.60 mg/L (range 0.28 mg/L to 0.60 mg/L) at 0.5 days posttreatment. The lowest LC50 values we obtained for glyphosate tested singly (385 mg glyphosate/L = 720 mg Rodeo/L) and in the mixture (89 mg glyphosate/L = 166 mg Rodeo/L) for all species were  $\geq 148$  times higher than glyphosate concentrations found in treated wetlands. Assuming that X-77 Spreader was present in treated wetlands at the same ratio tested in the laboratory, its highest concentration would be about

0.031 mg/L. The lowest LC50 value we obtained (6.0 mg/L) is 194 times higher than the projected concentration. Therefore, the application rate we used did not approach concentrations found to be acutely toxic to invertebrates in the laboratory.

The use of Rodeo alone or in mixture is not likely to produce acutely toxic conditions for native invertebrates in prairie pothole wetlands if label instructions are followed. The use of drift retardants and surfactants, however, should be monitored by wetland managers because the requirements for registration are not as strict as those for pesticides. Moreover, little is known about the chronic effects of glyphosate, and virtually nothing is known about chronic effects of X-77 Spreader or Chem-Trol on aquatic organisms.

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Table. Acute toxicity of Rodeo mixture components individually and in the mixture to aquatic invertebrates.

Taxon	Chemical	LC50 (mg/L)		Toxic unit <sup>a</sup>	Additive index and range
		Individual	In mixture		
Amphipod	X-77 Spreader	5.3	6.0	1.13	-0.43
	Rodeo	720	218	0.30	-1.49 to 0.16
	Chem-Trol		>28,000	18	<0.01
Midge	X-77 Spreader	10.0	8.2	0.82	-0.07
	Rodeo	1216	300	0.25	-0.65 to 0.64
	Chem-Trol	>28,000	243	<0.01	
Leech	X-77 Spreader	14.1	4.6	0.33	1.14
	Rodeo	1177	166	0.14	0.18 to 2.70
	Chem-Trol	>28,000	14	<0.01	

<sup>a</sup>Toxic units = LC50 of chemical in mixture ÷ LC50 of chemical tested individually.

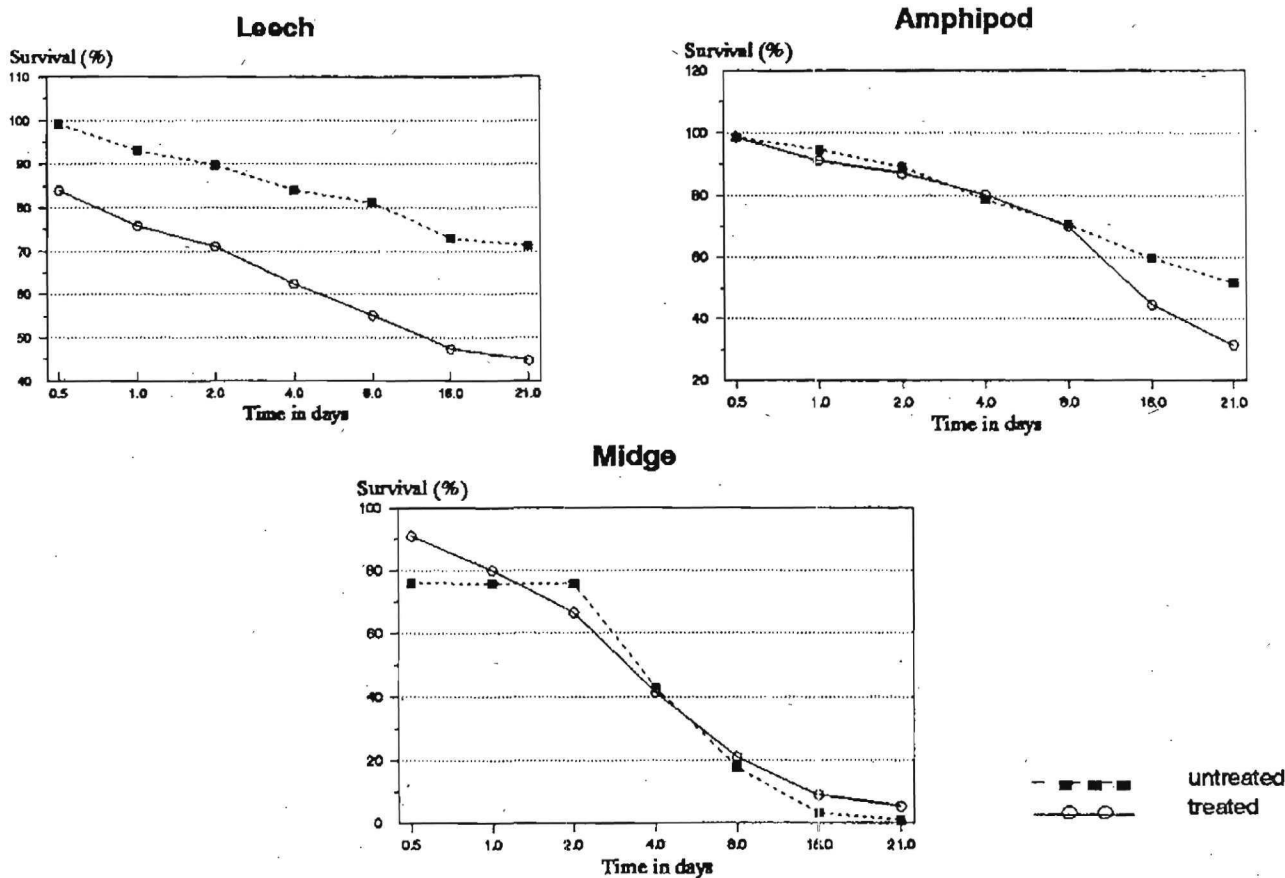


Figure. Survival of invertebrates after exposure to Rodeo herbicide in wetlands.