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LOW HERBICIDE CONCENTRATION FOUND IN STREAMFLOW AFTER A GRASS COVER IS KILLED

Abstract.—The grass cover on a steep Appalachian watershed was sprayed in 1966 with herbicides—first with atrazine and paraquat and later with atrazine and 2,4-D. Although grass growing in the stream channel was sprayed during the first treatment, atrazine and paraquat levels in water samples were low. For the second treatment, a 10-foot strip on either side of the channel was left unsprayed. No increase in atrazine concentration was noted, and no 2,4-D was detected. Thus, use of these chemicals does not appear to constitute a water pollution hazard when reasonable care is taken to protect streamside vegetation and the stream from direct contamination.

Fear is often voiced that contamination of streamflow will be an undesirable side effect of using herbicides as a silvicultural tool. A recent watershed study at the Coweeta Hydrologic Laboratory near Franklin, North Carolina, involved the use of herbicides and provided an opportunity to measure subsequent contamination of the stream. In 1958-60 a steep, 22-acre forested watershed was converted from hardwoods to Kentucky 31 fescue (*Festuca arundinacea* [Schreb.]) to determine the effect on water yield.[1] After 5 years, the grass cover was killed with herbicides to determine the maximum possible water yield increase from this watershed without a living cover. The Southeast Water Laboratory, Federal Water Pollution Control Administration, U. S. Department of the Interior, participated in this part of the study by monitoring effects of the herbicide treatment on water quality.

During May 3 through 6, 1966, a mixture of 3.5 pounds technical atrazine, 1 quart technical paraquat, and 1 quart surfactant[2] in 200 gallons of water per acre was applied to the watershed.[3] [4] The paraquat was used to obtain an immediate top kill of foliage and the atrazine was used to give lasting control. Chemicals were sprayed uniformly from a fire tanker through a fog nozzle over the entire watershed (fig. 1). No attempt was made to protect the watercourse from the chemical spray since dense grass was growing in the stream channel and a 100-percent kill of the transpiring vegetation was desired. The original spraying provided excellent initial kill of vegetation, but by mid-June scattered forbs, briers, ferns, and some grasses had regrown. Vegetation was sprayed a second time, during July 5 through 11, with a mixture of 3 pounds technical 2, 4-D (isobutyl esters), 4.5 pounds technical atrazine, and 1 quart of HDD surfactant in 200 gallons of water per acre.

After the first treatment, reduction of the protective grass covering in and along the stream course resulted in channel degradation. Therefore, a 10-foot buffer strip on either side of the stream was left unsprayed during the second treatment.

[1]Hibbert, A. R. Water yield changes after converting a forested catchment to grass. 1969. (Submitted for publication in *Water Resources Research,* American Geophysical Union, Washington, D. C.)

[2]Atrazine: 2-chloro-4-ethylamine-6-isopropylamino-*s*-triazine, manufactured by Geigy Chemical Corporation. Paraquat: 1,1' dimethyl-4,4'-bipyridinium bis (methyl sulfate), and surfactant: Ortho HDD, both manufactured by Chevron Chemical Company, Ortho Division.

[3]Mention of commercial products and sources does not constitute an endorsement of such products, to the exclusion of others equally acceptable, by the Forest Service or the Department of Agriculture, nor by the Federal Water Pollution Control Administration or the Department of the Interior.

[4]The authors are grateful to Chevron Chemical Company, Ortho Division, San Francisco, California, who provided without charge the paraquat and HDD surfactant for this study.

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Figure 1.—In the first treatment, herbicides were sprayed under high pressure to the entire watershed, including grass in the stream. In the second spraying, the buffer strip (inside the white dotted line) was left unsprayed.

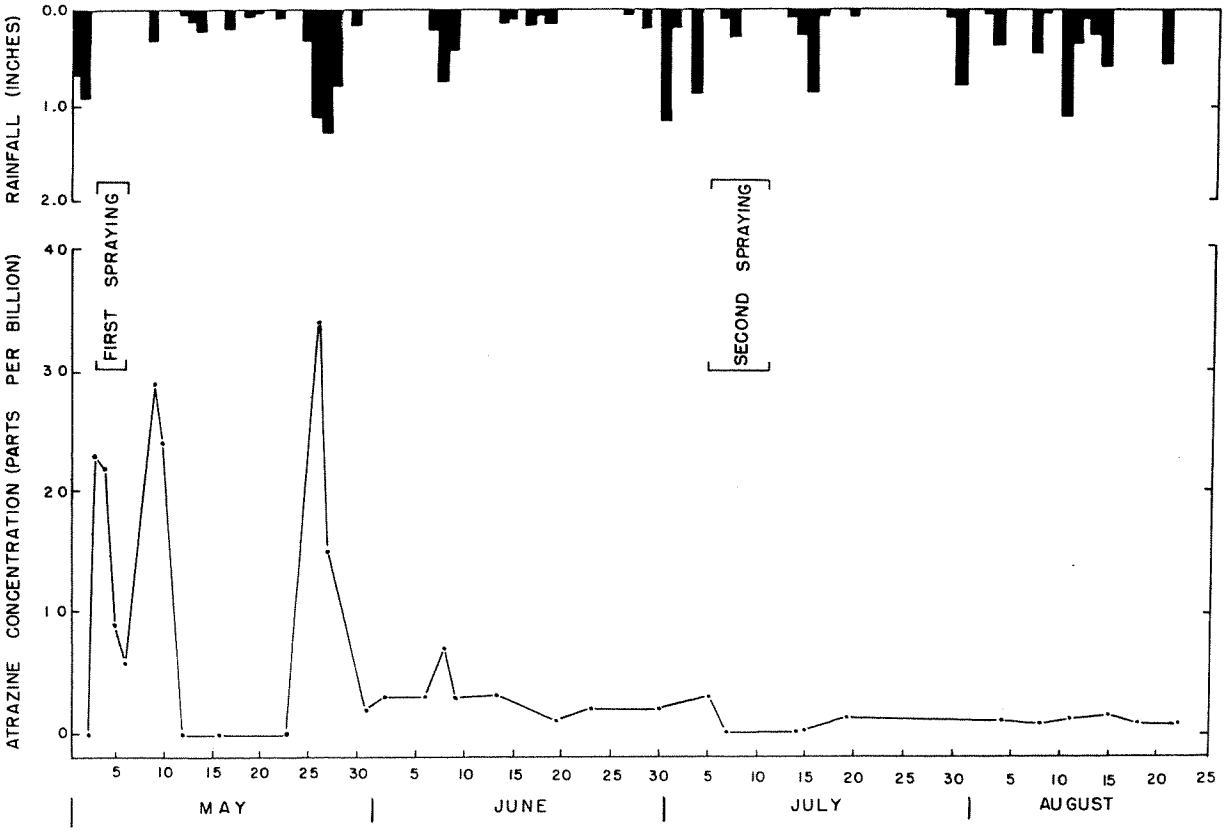

Figure 2.—Atrazine concentration in streamflow during and for 3½ months after herbicide treatment.

Water samples were collected in 1-gallon jugs cleaned by washing with acid and rinsing with distilled water. Samples of water flowing over the weir blade were collected twice weekly and during storms, and were shipped to the Southeast Water Laboratory in Athens, Georgia, for analysis. Atrazine residues were determined by microcoulometric gas chromatography and paraquat residues were detected by recommended procedures of the manufacturer.[5]

Water analyses indicated that only minute quantities of herbicides were present in the stream after the grass was sprayed with atrazine and paraquat. Paraquat is not readily mobile in the soil under the conditions of this study, and was detected in only 5 of more than 35 samples collected. Maximum concentration of paraquat was 19 parts per billion (p.p.b.); it was not detected in water samples after June 16.

Plotting the atrazine content (fig. 2) showed that atrazine concentrations, even those analyzed during operations when some spray fell directly in the channel, were quite low. During the period May 12 through 24, daily rainfall did not exceed 0.22 inch and no atrazine was detected in water samples. Following rains of 1.10 and 1.28 inches on May 26 and 27, concentrations of atrazine were detected. Presumably, these concentrations were the result of washoff from the dead grass and from soil contiguous to the watercourse. The maximum concentration of atrazine (34 p.p.b.) recorded during the study occurred during the May 26 storm. After May 27, all samples contained less than 10 p.p.b. atrazine. (The minimum reliable atrazine concentration detectable by the instrumentation and analytical techniques used was 10 p.p.b.)

Herbicides from the July 5 through 11 spraying did not appear to reach the stream; 2,4-D was never detected, and the atrazine content did not increase. Water samples collected during and immediately after spraying were negative for all herbicides. Thus, the 10-foot buffer afforded adequate protection against contamination of the stream.

The data support results of previous studies of streamflow contamination by pesticides at Coweeta[6] and herbicides on other experimental watersheds.[7] Water usually reaches streams of Southern Appalachian watersheds through soils rather than over the surface, so contamination of streams can be minimized by leaving an untreated buffer strip along each side. Judicious use of 2,4-D, paraquat, and atrazine does not appear to offer a serious pollution threat when reasonable care is taken to protect streamside vegetation and the stream itself from direct contamination.

[5]Analysis of paraquat residues in soil, method RM-8A, California Chemical Company, 1964.

[6]Grzenda, A. R., Nicholson, H. P., Teasley, J. I., and Patric, J. H. DDT residues in mountain stream water as influenced by treatment practices. J. Econ. Entomol. 57: 615-618. 1964.

[7]Reigner, I. C., Sopper, W. E., and Johnson, R. R. Control of riparian vegetation with phenoxy herbicides and the effect on streamflow quality. Northeast. Weed Contr. Conf. Proc., pp. 563-570. 1964.

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