

Picloram in Lysimeter Runoff and Percolation Water

by

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Picloram (4-amino-3,5,6-trichloropicolinic acid) has been demonstrated as a very effective herbicide in the control of herbaceous weeds and woody plants (BOVEY and SCIFRES 1971). The movement and persistence of picloram in soils and water have become a topic of much interest.

Field studies by SCIFRES et al (1971) demonstrated that the movement of picloram in surface runoff was governed mostly by the intensity of the rainfall, whereas the downward movement was controlled by the cumulative rainfall. These investigators found 17 ppb of picloram in runoff water a few days after application of 0.25 lb/A (0.28 kg/ha). After irrigation, 30 days later, less than 1 ppb of picloram was detected.

The present studies were conducted to investigate the movement of picloram in surface runoff and percolation water from a lysimeter that was initially treated with picloram at 2 lb/A (2.24 kg/ha). Runoff and percolation water resulting from natural rainfall were monitored for 24 months.

EXPERIMENTAL

Lysimeter and Treatment: Lysimeter Y101C (4.26 x 1.89 x 2.44 m) that was used for these studies is located at the North Appalachian Experimental Watershed at Coshocton, Ohio. The soil was Muskingum silt loam (reclassified as Dekalb: Typic Dystrachrept; loamy-skeletal, mixed, mesic). The profile is well drained over sandstone bedrock with 1.72% organic matter in the topsoil and a pH of 5.0. The predominant vegetation at the time of treatment was bluegrass and broadleaf weeds. No picloram was used at this site before this experiment.

The potassium salt of picloram (1.8 g) dissolved in 7.6 liters of water was applied to the lysimeter at 2.24 kg/ha on March 25, 1970. Potassium chloride (300 g) was added to the formulation to provide an inorganic tracer (Cl^-).

Runoff and Percolation Water Samples: The total storm runoff was delivered by gravity flow to an underground storage chamber where the volume of runoff was recorded and a sample from each event was automatically collected for analysis.

Percolation water samples were intercepted at 2.44 m beneath the lysimeter surface. When flow rates were sufficient, a 1-liter sample of percolating water was collected each week. Four such samples were combined each month to make a sample representing the total monthly volume. Both the runoff water and percolating water samples were analyzed for picloram and chloride at Beltsville, Maryland.

Chemical Analyses: Picloram was extracted from the water samples with ethyl ether and esterified with diazomethane. The methyl ester of picloram was quantitated by glc using an electron capture detector. The methylation and glc determination of picloram were described by WOOLSON and HARRIS (1967).

The analysis for chloride ions was performed with a commercially available chloride titrator (COTLOVE et al. 1958). The operation of the instrument was based on the coulometric generation of silver ions and the amperometric indication of the end point.

RESULTS AND DISCUSSION

Runoff Water: Data presented in Table 1 show that detectable levels of picloram appeared in runoff water up to 7 months after treatment. Runoff water during this period removed 0.13 mg or 0.007% of the picloram applied to the lysimeter.

The highest concentration of picloram (14.5 ppb) was detected on April 24, 1970, 1 month after treatment, after the first significant rainfall of 4.8 cm. Approximately 13% of the total loss of picloram was due to this single event that produced 1.2 liters of runoff. The largest amount of picloram lost in a single event was 40.7 μ g during the event of June 17th. This was 31% of the total loss during the experiment. The amount transported is, of course, a function of both concentration of picloram and the volume of water. On September 25th, six months after treatment, the largest volume of runoff water (13.6 liters) contained 1.1 ppb of picloram.

TABLE 1

Picloram concentration in runoff water from lysimeter Y101C after application of 2.24 kg/ha on March 25, 1970.

Date	Picloram (ppb)	Runoff (liters)	Rainfall (cm)
April 24, 1970	14.5	1.2	4.8
May 13, 1970	12.2	0.6	2.7
June 17, 1970	11.0	3.7	2.9
July 8, 1970	6.1	4.2	3.4
July 29, 1970	2.9	8.0	1.9
September 25, 1970	1.1	13.6	4.1
October 11, 1970	0.7	2.5	2.8
February 12, 1971	0.0	19.8	0.9

The data indicate a steady decrease in picloram concentration with time. It is evident, therefore, that the risk of water contamination by runoff is greatest soon after application. No picloram was detectable in the runoff water one year after treatment.

Our data agree with the data reported by BAUR et al. (1972b). These workers detected picloram residues ranging from 26.2 to 89.7 ppb in runoff water during the first week after treatment with 1.12 kg/ha. After 6 months, the residue level declined to less than 1 ppb with a cumulative rainfall of 35.5 cm. Our results indicate that a residue level of 1.1 ppb appeared 6 months after initial treatment at 2.24 kg/ha. During this period, the lysimeter received a cumulative rainfall of 20 cm.

Percolation Water: Picloram was initially detected at 1.0 ppb in the percolation water that was intercepted 2.4 m beneath the soil surface nearly one year after treatment (Table 2). During the March 1971 sampling period, the average chloride concentrations increased from a background level of 6 ppm or less to 16 ppm in the percolating water. This was a further indication that the applied chemicals had moved through the soil profile. Approximately 3,836 liters of water was necessary to leach the picloram and the chlorides from the surface to the 2.4-m depth of the Muskingum silt loam soil.

TABLE 2

Picloram concentration in percolation water from lysimeter Y101C after application of 2.24 kg/ha on March 25, 1970.

Date	Picloram (ppb)*	Chlorides (ppm)*	Percolation Water (liters)
March 1970-Feb. 1971	0	6	3,836
March 1971	1.0	16	715
April 1971	1.2	20	203
May 1971	0.7	20	264
June 1971	1.1	22	85
July 1971	1.2	23	19
August 1971	**	**	12
September 1971	**	**	6
October 1971	**	**	3
November 1971	**	**	2
December 1971	**	**	3
January 1972	**	**	8
February 1972	0.6	24	237
March 1972	0.5	24	577

* Monthly values are the average of four weekly samples.

** Samples were not analyzed because of insufficient percolation water.

The residue levels of picloram detected were similar to those obtained with 2,4,5-T (2,4,5-trichlorophenoxyacetic acid) from an earlier lysimeter study (EDWARDS and GLASS 1971). Nine months after application (11.2 kg/ha), a residue level of 0.5 ppb of 2,4,5-T was detected in the percolation water from lysimeter Y101B.

The results from the present study support the findings of BAUR et al.(1972). They found that the residue levels of picloram were 1.0 ppb in soil samples taken from the 2.44-m depth one year after treatment with 1.12 kg/ha. The treated area received a cumulative rainfall of 62.5 cm.

During the sampling periods August 1971 through January 1972 in the present study, volumes of percolation water were insufficient for reliable analyses. The lack of water for percolation on the lysimeter during these periods appeared to be due to evapotranspiration in the summer and the frozen soil surface during the winter. However, during the last 2 months of this 24-month experiment, residue levels of picloram of 0.6 ppb and 0.5 ppb were detected.

Adsorption of picloram (1.7%), as the anion, was very low in laboratory studies (NEARPASS 1972) with the topsoil from the Coshocton experimental site. With approximately 0.2% of the total picloram appearing in the percolation water over the 24-month period in the present study, leaching of picloram does not appear to be a major route of dissipation in this soil.

ACKNOWLEDGMENT

The authors wish to thank Mr. Elmer C. Simpson for conducting the chloride analyses and Dow Chemical Company, Midland, Michigan, for supplying the picloram.

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