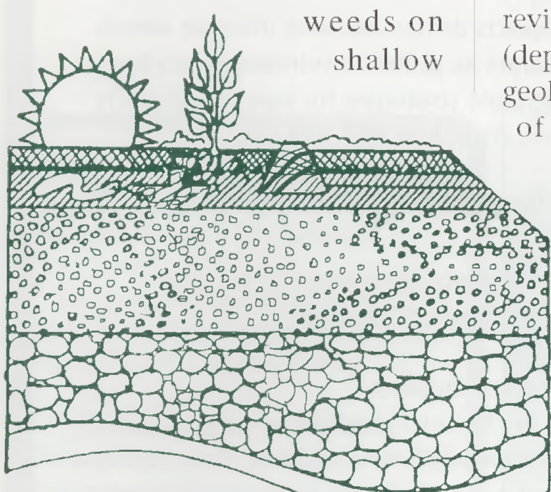
TechLine

Information About Invasive/Noxious Plant Management

March, 1998

Environmental Fate of Herbicides in Soils

Environmental protection is vital when considering the implementation of any weed management program.The key to managing noxious weeds while protecting the environment is based on our ability to identify high-risk sites. When evaluating sites for herbicide application, an important criteria is depth to groundwater. Land managers proposing herbicide treatment for weeds on shallow groundwater areas should conduct on-site evaluations of soil type and permeability. A weed management plan can then be developed that addresses the environmental issues.



Site assessments that include a review of environmental factors (depth to groundwater, soils, and geology) and adequate knowledge of herbicide properties and implementation of integrated weed management (IWM) methods is the key to developing a comprehensive, environmentally safe weed control program.

The purpose of this *TechLine*

See "Groundwater Protection" on page 6

"There is nothing worse than a sharp image of a fuzzy concept."

Ansel Adams

Inside TechLine

Weed Management Resource Library 1-800-554-WEED (9333)

The *Weed Management Resource Library* (WMRL) contains a wide variety of information resources to improve your noxious and invasive plant management. The Library provides you with quick, convenient access to as many resources as possible in one location.

A Library catalog lists the resources, along with a brief description of each piece of information and how it fits into a complete weed management program.

In the near future, the *Weed Management Resource Library* will be on the Internet for those with computer access. Until then, noxious weed and invasive plant managers can call the Library toll-free at 1-800-554-WEED (9333).

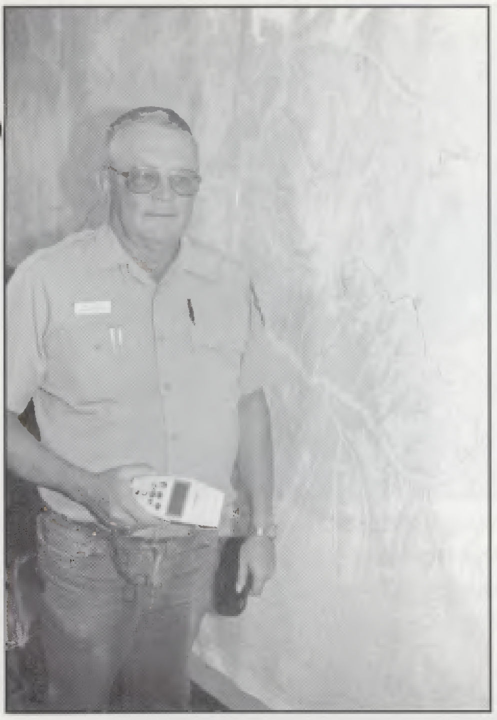
There is no charge for using the Library. However, users may be asked to provide follow-up information explaining how they used Library materials and the effectiveness of the resource. The Library expands continuously. It is updated whenever new resources are developed and proven effective.

The Library serves as a network to place you in touch with other managers and experts. For instance, if you are interested in talking with managers who have controlled noxious weeds in a waterfowl refuge area, you simply call the 800 number and we will provide you with the names and phone numbers of fish and wildlife people with this experience. In this way, the Library serves as a central clearinghouse of weed management knowledge and expertise. We may not have all the answers, but we can put you in contact with someone who has experience in your area of interest.

Of course, we encourage library users and other vegetation management professionals to share their knowledge when they discover a technique or a useful tool that might help others. In this respect, the Library is really YOUR Library and will be as useful as you make it.

Sample of Items in the Weed Management Resouce Library include:

- Research studies on the impacts of noxious and invasive weeds
- Study on biological invasions as global environments change
- Successional weed management strategies for rangeland study
- Research studies to help you complete EISs and EAs
- Weed awareness videos
- Weed ID and educational slide sets
- Weed ID postcards
- A list of weed management experts from across the region
- An awareness and education "how-to" booklet
- A mapping guidelines booklet
- A prevention program "how-to" booklet
- A monitoring and evaluation "how-to" booklet
- A "how-to" weed awareness weed ID kit including news releases and weed line drawings that are camera-ready for newsletters, brochures, and other awareness-raising uses
- University economic studies detailing the impacts of weeds
- Copies of state weed laws
- Herbicide guides, research, and product comparison studies
- Calibration and training aids
- Biological and non-chemical control options
- ... and many other resources



Larry Shults, Natural Resource Specialist for the Department of Interior Bureau of Land Management (BLM) in Meeker, CO, purchased two Trimble Geo Explorer II GPS units for weed inventory work. Two mappers will dedicate five to six months in 1998 to mapping areas of the Resource Area that have never been inventoried for weeds.

Bureau of Land Management
Meeker, Colorado

Mapping, Staff Cross-Training, Local Cooperation Key BLM's Progress

By Charles Henry
TechLine Editor

If you could distill the White River Resource Area's weed manage-ment program down to its core, you would find all the basic elements which, if implemented correctly, lead to success for almost any noxious weed program. Larry Shults, Natural Resource Specialist for the Department of Interior Bureau of Land Management (BLM) in Meeker, CO, faces conditions typical for many federal land managers. Shults manages weeds spread over a huge area – 1.4 million acres in the Resource Area. And he does it with fewer staff people than their agency employed five years ago.

"I honestly feel our biggest obstacle to successfully managing our weed problem is that we do not see 90% of the Resource Area in any one year. We are doing a pretty good job on the weeds that we know about, but truthfully, we do not have our arms around the complete problem yet," Shults says. "But we are successful because awareness is high and we are doing something about the weeds BEFORE they get out of hand. And we are preventing new infest-ations."

See "White River" on next page

Noxious Weeds of Concern on White River Resource Area

Houndstongue (*Cynoglossum officinale* L)
Leafy spurge (*Euphorbia esula* L.)
Canada thistle (*Cirsium arvense* (L.)
Musk thistle (*Carduus nutans* L.)

Other Species of Concern:

Downy brome (*Bromus tectorum* L.)
Halogeton (*Halogeton glomeratus*)
Mullein (*Verbascum thapsus* L.)

Shults spent his first weed funds on building awareness with signs like this one. He also works closely with the county and local ranchers to build cooperative efforts.

"White River"
Continued from previous page

This situation – vast areas of extremely rough, isolated terrain, coupled with a harsh climate – drives how Shults manages priorities. First, he involves as many people in the program as possible, forming alliances and building partnerships wherever he can.

Second, he spent his initial program dollars on education and awareness, so the BLM has an informed network of people, within and outside the agency. Ranchers, energy company employees, hunters, recreationists, and other users of the Resource Area now contribute information about where weed species exist. Third, using an integrated approach, the agency vigorously attacks new invaders before they can gain a foothold.

Shults says they use the management method that fits the weed and the site it infests. This includes digging of houndstongue in riparian areas, mowing, hand spraying with backpacks, and boom spraying from two pickup-mounted units where they can. They use Tordon* 22K herbicide and 2,4-D, and some Escort herbicide, although their best success has been with the Tordon 22K.

Shults says they have not found any areas suitable for biological releases, but they cooperate with the Colorado Division of Wildlife on neighboring property where *Apthona* beetles have been released on leafy spurge. And they are beginning to work on a growing perennial pepperweed (*Lepidium latifolium* L.) problem in riparian areas using intensive sheep grazing.

"Within the agency, I have outstanding cooperation from our

*Trademark of Dow AgroSciences, LLC Tordon 22K is a federally Restricted Use Pesticide.

Shults says they use the management method that fits the weed and the site it infests. The White River Area BLM is beginning to work on a growing perennial pepperweed (*Lepidium latifolium* L.) problem in riparian areas using intensive sheep grazing.

"The key to our success, without a doubt, has been the dedication of the people who have become involved. And within the agency, I have outstanding cooperation from our wildlife people, energy technicians and engineers, and others."

Observed Weed Impacts

Compared to many areas of public land, the White River Resource Area does not have a severe noxious weed problem yet. But Larry Shults, BLM natural resource specialist, says environmental impacts of weeds are becoming more evident every year. He lists the following observed impacts:

1. Elk so infested with houndstongue in their hair coat to severely impact their health.

2. Canada thistle monocultures developing in some riparian areas.

3. Pure stands of black henbane in some areas.

4. No Threatened & Endangered Species are impacted by weeds yet, but two species, Dudley Bluffs Bladder pod (*Lesquerella congesta*) and Piceance twin pod (*Physaria obcordata*) have been found in the Resource Area.

5. Portions of the Resource Area have potential for black-footed ferret reintroduction, so biodiversity maintenance is critical.

wildlife people, energy technicians and engineers, and others. During the spray season, our cross-trained secretaries in the office even get involved as spray truck operators," Shults says. "With downsizing in the agencies, everyone wears two or three hats. When a biologist does a riparian survey, he or she also surveys for weeds."

Shults' budget has grown 87% since 1995 for weeds. He leverages his funds against a prioritized list of weeds **(see Weeds of Concern on page 3)**. "We focus on these species. But again, I am afraid we don't get much done yet on some species like downy brome or halogeton, which are also on the BLM's weeds of concern list.

Partnerships are the key to getting the most from your available funds. I use a portion of my budget as seed money to help other groups organize – and that always multiplies our efforts."

Last year, Shults formed one partnership with five oil companies with BLM leases, four pipeline companies, the Forest Service, Rio Blanco County, the Colorado Division of Wildlife (DOW), and 40 ranchers with BLM grazing permits. He held four training sessions that covered everything from weed identification to sprayer calibration. With the cooperation of Phyllis Lake from Meeker, Shults helped fund a ranch wife field day and 4-H weed project.

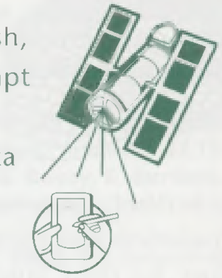
"More than 25 women and 40 high school kids spent the morning learning weed identification and their impacts. In the afternoon, we adjourned to our ranch for hands-on demonstrations on backpack and ATV spraying," Phyllis Lake explains. "We covered proper clothing, calibration and mixing, and proper chemical container disposal. Many of these women will do the bulk of the weed work on their ranches, so we felt it was important that they were educated and trained."

"The key to our success, without a doubt, has been the dedication of the people who have become involved," Shults concludes. "People like Phyllis, Paul Burgell, Rio Blanco County weed supervisor, and Tom McClure with the Forest Service in Meeker are the reasons we have progressed as much as we have."

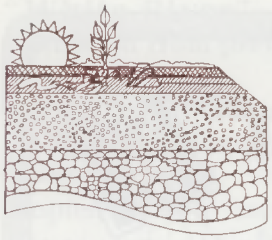
Mullein is an invader species that Shults is monitoring. He suspects they will find more in areas they have not previously inventoried.

Complimentary Mapping Units Used by BLM, County, and Landowners

Next year, $21,000 of the White River Resource Area's weed budget will fund a major inventory effort using geographic positioning satellite (GPS) units. The BLM has purchased two Trimble Geo Explorer II units for $3,000 each. These units compliment similar GPS units used by the county and Forest Service on adjoining lands. Two mappers will dedicate five to six months in 1998 to mapping areas of the Resource Area that have never been inventoried for weeds. The units feed single point, weed species, acreage, weed density, and treatment history into a GPS program preloaded with quad maps of the area.



"In one push, we will attempt to close the inventory data gap that prevents us from really feeling good about our progress to date," Shults says. "Once we know what type of weed problems exist in the areas where we have never looked, we will have a much truer picture of where we stand. Our goal is to have everyone – BLM, Forest Service, county, and even private ranchers – file a report with GPS coordinates on a regular basis on what they are doing. The goal is to eliminate potential duplication and through cooperation, shrink the expansive landscape we all work in down to a manageable size, relative to weed containment."



"Groundwater Protection"

Continued from page 1

is to further understand factors influencing herbicide degradation and movement in soil and to relate those factors to field studies conducted under northern rangeland conditions.

Due to the complex nature of this subject, *TechLine* presents summaries of two papers on movement of herbicides in soils. Because of the length and complexity of the Watson, Rice, and Monnig paper, only the abstract and conclusion of the study are presented in this issue along with all the references. Please remember, the complete paper may be obtained through the *Weed Management Resource Library*.

To further understand this subject, a separate paper entitled "Movement and Degradation of Tordon* herbicide in Northern Rangeland Environments" by Duncan and Halstvedt is included in this issue of *TechLine*. This paper summarizes the Watson, Rice, Monnig paper and adds information from an additional Montana groundwater study. This additional information was published in the proceedings of the Western Society of Weed Science.

Environmental Fate of Picloram Used for Roadside Weed Control

by V. J. Watson, P. M. Rice, and E. C. Monnig

Authors Watson and Rice are with the Div. of Biological Sciences/Environ. Studies, Univ. of Montana, Missoula, MT 59812; and Monnig is USFS District Ranger on the Kootenai National Forest, Libby MT 59923.

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ABSTRACT

The herbicide picloram (4-amino-3,5,6-trichloro-2-pyridine carboxylic acid) was applied to control spotted knapweed (*Centaurea maculosa* Lam.) in the northern Rockies to determine persistence in soils and vegetation, losses by photodegradation, rainfall induced migration, and potential contamination of surface and groundwater.

Two sites were selected to represent best case and worst case conditions (within label restrictions) for on-site retention of picloram. A valley bottom terrace was treated with 0.28 kg/ha of picloram in the spring of 1985, and sampled over the following 445 d. In the spring of 1986, 1.12 kg/ha of picloram was applied to both sides of a minimal construction logging road extending 4 km along a stream (102 to 815 m^3) that drains a granitic upper mountain watershed. Of the 17.1 km^2 watershed, 0.15% (2.5 ha) was sprayed.

Vegetation, soils, surface water, and groundwater near the road were sampled during the 90 d following application. At the valley bottom site, 36, 13, and 10.5% of the picloram applied persisted after 90, 365, and 445 d, respectively. At the mountain watershed site, 78% persisted after 90 d, and picloram was not detected in the surface or groundwaters during the 90 d following application. Depending on the timing of delivery, as little as 1% or less of the application could have been detected after delivery to the stream. Loss by photodegradation during the first 7 d after treatment was important at both sites.

CONCLUSIONS

An application of 0.28 kg/ha of picloram to a valley bottom site with good herbicide retention characteristics decayed to 56% after 7 d, 36% after 90 d, 13% after 1 yr, and 10.5% after 1.25 yr. The 44% loss during the first week was attributable to photodecay that was the dominant dissipation process during the first growing season.

Picloram residues were not detected below a soil depth of 50 cm, and all losses were a result of on-site breakdown. On a mountain logging road with poorer retention and decay characteristics, 86% of a 1.12 kg/ha application was still present after 7 d and 78% persisted after 90 d. Photodecay was less important because of more shade and because rainfall occurred shortly after application to water saturated soils.

Picloram was leached to the maximum depth sampled (1 m) within a week. Although the water table was within 1 m of the soil surface at some points between the spray zone and the stream, no herbicide was detected in streamflow nor groundwater.

Most off site loss via infiltration and/or surface flow should have occurred during the 24 h following the first storm after spraying. The dilution capacity from increased streamflow following this storm could absorb 0.010 kg or 0.3% of the application without detection. Any picloram leaving the mountain watershed was at a concentration below the analytic detection limit (0.5 mg/m^3), well below levels causing detrimental effects on beneficial uses of water (e.g., irrigation, aquatic life).

REFERENCES

Anonymous 1972. USDA pesticide manual. Section 222.13c. U.S. Gov. Print. Office, Washington, DC.

Anonymous. 1977. Pesticide analytical manual. Section 180.292. US-FDA. U.S. Gov. Print. Office, Washington, DC.

Anonymous 1978. Methods for benzidine, chlorinated organic compounds, PCP, and pesticides in water and wastewater. EPA 600/ 4-81-0054. USEPA, Cincinnati, OH.

Anonymous. 1987. Part 180.292—Picloram, tolerances for residues. p.336. In Code of Federal Regulations 40. U.S. Gov. Print. Office Washington, DC.

Baur, J.R., R.W. Bovey, and M.G. Merkle. 1972. Concentration of picloram in runoff wafer. Weed Sci. 20:309-313.

Bjerke, E.L. 1973. Determination of residues of picloram in soil by gas chromatography. ACR 73.3.21 May. Dow Chemical Co., Midland, MI.

Bovey, R. W., E. Burnett, C. Richardson, J. R. Baur, M .G . Merkle and D.E. Kissel. 1975. Occurrence of 2,4,5-T and picloram in subsurface water in the Blacklands of Texas. J. Environ. Qual. 4.103-106.

Bovey. R.W., E. Burnett, C. Richardson, M.G. Merkle, J.R. Baur and W.G. Knisel. 1974. Occurrence of 2,4,5-T and picloram in surface runoff water in the Blacklands of Texas. J. Environ. Qual. 3:61 -64.

Bovey, R.W., F.S. Davis, and M.G. Merkle. 1967. Distribution of picloram in huisache after foliar and soil applications. Weeds 15:245-249.

Bovey, R.W., and C.J. Scifres. 1971. Residual characteristics of picloram in grassland ecosystems. Texas. Agric. Stn. B-l l l l.

Davis, E.A., and P.A. Ingebo. 1973. Picloram movement from a chaparral watershed. Water Resour. Res. 9: 1304- 1313.

Davidson, J.M., and R.K. Chang. 1972. Transport of picloram in relation to soil physical conditions and pore-water velocity. Soil Sci. Soc. Am. Proc. 36:257-261.

Farmer, W.J., and Y. Aochi. 1974. Picloram sorption by soils. Soil Sci. Soc. Am. Proc. 38:418-423.

Fryer, J.D., P.D. Smith, and J.W. Ludwig. 1979. Long-term persistence of picloram in a sandy loam soil. J. Environ. Qual. 8:83,86

Getzendaner, M.E., J.L. Herman, and B.V. Giessen. 1969. Residues of 4-amino-3,5,6-trichloropicolinicacid in grass from applications of Tordon herbicides. J. Agric. Food Chem. 17:1251 - 1256.

Grover, R. 1967. Studies on the degradation of 4-amino-3,5,6-trichloropicolinic acid in soil. Weed. Res. 7:61-67.

Grover, R.1971. Adsorption of picloram by soil colloids and various other adsorbents. Weed Sci. 19:417-418.

Hall, R.C., C.S. Giam, and M.G. Merkle. 1968. The photolytic degradation of picloram. Weed Res. 8:292-297.

Hamaker, J.W., C. R. Youngson. and C.A. I. Goring.1967. Prediction of the persistence and activity of Tordon herbicide in soils under field conditions. Down Earth 23(2):30-36.

Hance, R.J. 1967. Decomposition of herbicides in soil by non-biological chemical process. J. Sci. Food Agric. 18:544-549.

Herr, D.E., E.W. Stroube, and D.A. Ray. 1966a. The movement and persistence of picloram in soil. Weeds 14:248-250.

Herr, D.E., E.W. Stroube, and D.A. Ray. 1966b. Effect of Tordon residues on agronomic crops. Down Earth 22(2): 17- 18.

Johnsen, T.N. 1980. Picloram in water and soil from a semiarid Pinyon-Juniper watershed. J. Environ. Qual. 9:601-605. 205

Johnsen, T.N., and R.D. Martin. 1983. Altitude effects on picloram disappearance in sunlight. Weed Sci. 31:315-317.

Kenaga, E.E. 1969. Tordon herbicides—evaluation of safety to fish and birds. Down Earth 25:5-9.

Keys, C.H., and H.A. Friesen.1968. Persistence of picloram activity in soil. Weed Sci. 16:341-343.

Kutschinski, A.H. and V. Riley. 1969. Residues of steers fed 4amino-3,5,6-trichloropicolinic acid. J. Agric. Food Chem. 17:283287.

Lacey, J.R. 1983. A complete takeover by knapweed in 2001? Montana Farmer-Stockman 70:32-35.

Marley, J.M.T. 1980. Persistence and leaching of picloram applied to a clay soil on the Darling Downs. Queensl. J. Agric. Anim. Sci. 37.15-25.

Mayeux, H.S., Jr., C.W. Richardson, R.W. Bovey, E. Burnett, M. G. Merkle, and R.E. Meyer. 1984. Dissipation of picloram in storm runoff. J. Environ. Qual. 13:44-48.

Merkle, M.G., R.W. Bovey, and R. Hall. 1966. The determination of picloram residues in soil using gas chromatography. Weeds 16:161-164.

Nash, R.G. 1980. Dissipation rate of pesticides from soils. p. 560606. In W.G. Knisel (ed.) CREAMS—A field scale model for chemicals, runoff, and erosion from agncultural management systems. Vol. 3. USDA Conserv. Res. Rep. 26. U.S. Gov. Pnnt. Office Washington, DC.

Nationai Research Council. 1983. Drinking water and health. Vol. 5. Natl. Academy Press Washington, DC.

Neary, D.G., P.B. Bush, J.E. Douglas, and R.L. Todd. 1985. Picloram movement in an Appalachian hardwood forest watershed. J. Environ. Qual. 14:585-592.

Norris, L.A. 1970. Degradation of herbicides in the forest floor. p. 397-411. *In* C.T. Youngberg and C.B. Davey (ed.) Tree growth and forest soils. Proc. 3rd North American Forest Soils Cont, Raleigh, NC. Aug. 1968, Oregon State Univ. Press, Corvallis.

Ping, C.L., H.H. Cheng, and B.L. McNeal. 1975. Variations in picloram leaching patterns for several soils. Soil Sci. Soc. Am. Proc. 39:470-473.

Rao, P.S.C., R.E. Green, V. Balasubramanian, and Y. Kanehiro. 1974. Field study of solute movement in a highly aggregated oxisol with intermittent flooding.11: Picloram. J. Environ. Qual. 3:197202.

SciErcs, C.J., R.R. Hahn, and M.G. Merkle. 1971a. Dissipation of picloram from vegetation of semi-arid rangelands. Weed Sci. 19,329-332.

Scifres, C.J., R.R. Hahn, J. Diaz-Colon, and M.G. Merkle. 1971b. Picloram persistence in semiand rangeland soils and water. Weed Sci. 19:381-384.

Scifres, C.J., O.C. Burnside, and M.K. McCany. 1969. Movement and persistence of picloram in pasture soils of Nebraska. Weed Sci. 17:486-488.

Sirons, G.J., R. Frank, and R.M. Dell. 1977. Picloram residues in sprayed MacDonald-Canier Freeway right-of-way. Bull. Environ. Contam. Toxicol. 18:526-533.

Trichell, D.W., H.L. Monon, and M.G. Merkle. 1968. Loss of herbicides in runoff wafer. Weed Sci. 16:447-449.

Wauchope, R.D., and R.A. Leonard. 1980. Maximum pesticide concentrations in agricultural runoff: A semiempincal prediction formula. J. Environ. Qual. 9:665-672.

Weed Science Society of America. 1983. Herbicide handbook. 5th ed. Champaign, IL.

Wheatley, G.A. 1973. Pesticides in the atmosphere. p. 365-408. In C A Edwards (ed.) Environmental pollution by pesticides. Plenum Press, New York.

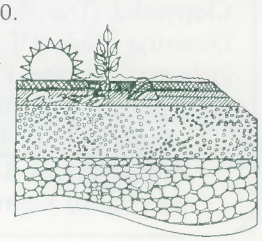
Woodward, D.F.1979. Assessing the hazard of picloram to cutthroat trout. J. Range Manage. 32:230-232.

Woodward, D.F. 1976. Toxicity of herbicides dinoseb and picloram to cutthroat (*Salmo clarki*) and lake trout (*Salvelinus hamaycush*). J Fish. Res. Board Can. 33:1671-1676.

Youngson, C.R., C.A.I. Goring, R.W. Meikle, H.H. Scott, and J.D. Griffith. 1967. Factors influencing the decomposition of Tordon herbicide in soils. Down To Earth 23(2):3-10.

*Trademark of Dow AgroSciences, LLC
Tordon 22K is a federally Restricted Use Pesticide.

More on Groundwater Protection on next page



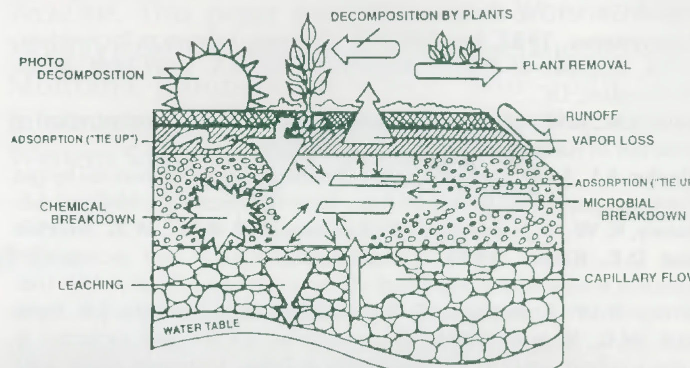
Movement and Degradation of Herbicides in Northern Rangeland Environments

By Celestine Duncan and Mary Halstvedt

Author Duncan is an independent researcher with Weed Management Services, Helena, MT and Halstvedt is Senior Research Biologist with Dow AgroSciences, LLC, Billings, MT.

Once a herbicide is applied to soil or vegetation there are many different processes that can occur. ***Figure 1 at right*** shows the potential fate of a herbicide in the environment. There are several factors that influence herbicide movement and degradation in soil. These factors include both herbicide properties and environmental factors.

Figure 1: Fate of Herbicides in the Environment



From Martin, A.H. et al. 1977. Herbicide Carryover.

Herbicide Properties Affecting Mobility in Soils

1. Water Solubility is the quantity of a herbicide that can be dissolved in a liquid such as water. The larger the number, the greater the solubility of a herbicide (***Table A***).

2. Adsorption is the distribution of a herbicide between soil particles and the soil solution. The amount and type of clay & organic matter present in the soil influences how tightly a herbicide is absorbed. Adsorption coefficients are shown as a K_{oc} factor. The higher the number, the more binding that herbicide is to soil particles (***Table A***).

3. Persistence is the length of time a herbicide remains active in a soil system. ***Table A*** shows the half life values in days for several herbicides. Persistence will vary based on a) application rate; b) temperature; and c) moisture content of the soil and soil organic matter. In general, herbicide breakdown is more rapid under warm, moist conditions with high organic matter.

Table A is a summary of the different herbicide properties that affect mobility for five herbicides. The first four herbicides are all considered mobile compounds. Compare the values for these herbicides to glyphosate which is a non-mobile compound. Although glyphosate is very soluble in water, it is bound so tightly to soil that it is not mobile.

Environmental Factors

Environmental factors are extremely important in determining the sensitivity of a site for herbicide movement and the potential for contamination of groundwater resources. Important factors include:

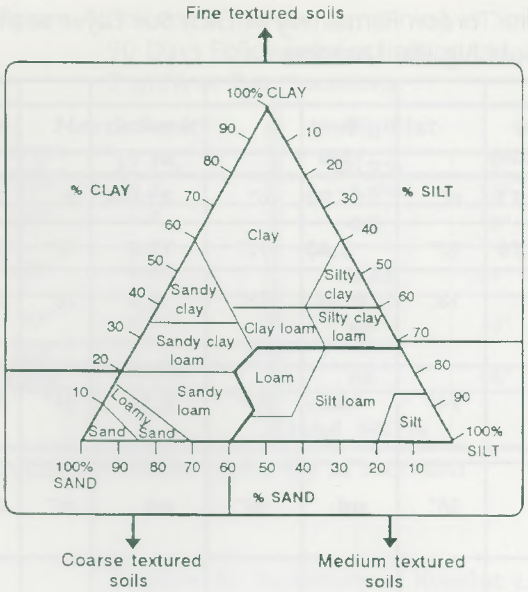
1. Depth to groundwater is one of the most important factors. The closer the water table is to the ground surface, the greater the risk for contamination.

2. Soil texture. Coarse textured soils such as sand and loamy sand (left corner of ***Figure 2***) are the most

TABLE A: *SUMMARY: HERBICIDE PROPERTIES AFFECTING MOBILITY*

HERBICIDE	SOLUBILITY (ppm)	ADSORPTION (K_{oc})	HALF LIFE (days)
Metsulfuron (Ally[1])	1750-9500	30-55	60-210
Clopyralid (Transline[2])	1000	5-30	21-100
Dicamba (Banvel[3])	6500	8	21-90
Picloram (Tordon[2])	430	13-70	28-400
Glyphosate (Roundup[4])	1570	24025	60-90

[1]Trademark of E.I. duPont de Nemours / [2]Trademark of Dow AgroSciences, LLC / [3]Trademark of Sandoz Ltd. / [4]Trademark of Monsanto Company



susceptible to herbicide movement. As the amount of clay and silt particles increase, the ease at which herbicides can move decreases. It is important to consider soil properties throughout the soil profile, not just surface soil.

3. Permeability is the ease at which gases and liquids pass through a layer of soil. Soil texture is an important factor influencing permeability. Other factors including sodium content and soil structure will also affect soil permeability.

4. Climate. Precipitation is generally considered low on much of our western rangeland which will limit herbicide movement. However, if you alter the environment through irrigation, herbicide movement on site may be substantially changed.

5. Geology of an area is also important. It is critical to understand the type of bedrock on a site and potential for direct introduction of herbicides into the groundwater. An understanding of land forms is also important when considering the potential for flooding on a site.

Local Research:

Tordon herbicide is one of several chemicals categorized as a mobile compound because of its solubility, persistence, and adsorption properties. However, it is important to understand what the term "mobile compound" means in relation to actual movement and degradation of a herbicide applied under field conditions.

Three field research sites were established in Montana to evaluate applications of Tordon under various environmental conditions. The objective of these studies was to measure how deep Tordon moved in the soil and levels remaining after a specified time period. A summary of these studies is described below.

Study #1: Environmental Fate of Picloram Used for Roadside Weed Control (See abstract)

This study was conducted in Missoula County and involved two study sites representing "best case" and "worst case" conditions for applications of Tordon. ***Table 1*** below shows environmental factors present at each location. Site 1 (best case) was located near Fort Missoula on a level floodplain. Tordon at 1 pint (.25 lb. a.i./ac.) was applied in the spring of 1985. Soil, vegetation and groundwater samples were collected up

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Table 1. Site Characteristics for Three Locations Where Movement of Tordon and Dissipation in Soil Were Measured

Site	***Fort Missoula***	***North Fork Elk Creek***	***Big Flat***
Landform	Valley bottom field	Mountain watershed with logging road by stream	Floodplain
Application rate (lb./ac)	0.25 lb./ac.	1.0 lb./ac.	1.0 lb./ac.
Soil Texture	Loam	Sandy loam	Sandy loam
Percent sand	33%	61%	60%
Organic matter	2-4%	0.8-2%	0.6-2%
Soil permeability	mod. (.5-2 in./hr.) rapid (6-20 in./hr.)	mod. rapid (2-6 in./hr.)	mod. rapid rapid (4-18 in./hr.)
Soil moisture (at application)	<5%	25% (field capacity)	8%
Depth to groundwater	30 ft.	3-9 ft.	11-15 ft.
Distance to surface water	1,640 ft.	Shortest distance 3.28 ft. Average distance 108 ft.	Not applicable
Slope	< 1%	6%	<1%
Rainfall (1st 90 days)	6.7 in.	2.7 in.	2.06 in.

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Groundwater Protection

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to 445 days after application.

Site 2 (worst case) was located adjacent to a logging road on the North Fork of Elk Creek. Tordon at 2 quarts (1 lb. a.i./ac.) was applied as a broadcast application along both sides of the road. Vegetation, soil, surface water, and groundwater samples were collected up to 90 days following application.

Results at the Fort Missoula site indicated that Tordon moved to a maximum depth of 20 inches at 90 days following application. In addition, 36% of Tordon applied remained at the site 90 days after treatment. At the North Fork site, 78% of Tordon persisted 90 days after application residues of Tordon were detected to the 40 inch sampling depth. Loss by photodegradation during the first 7 days after treatment was important at both sites. Tordon was not detected in the surface water or groundwater at either location.

Figure 3: Percent Tordon Remaining in Each Soil Layer at the Missoula Big Flat Location.

	0 Day		3.5 Month		12 Month		28 Month
Vegetation	**87.6%**		**13%**		**ns**		**ns**
Soil	**10.73**	6″	**56.90**	6″	**25.6%**	6″	**2.4%**
	1.70	12″	**2.40**	12″	**19.8**	12″	**1.3**
	ns	18″	**0.50**	18″	**2.7**	18″	**2.1**
	ns	24″	**4.25**	24″	**0.36**	24″	**1.6**
	ns	36″	**nd**	36″	**nd**	36″	**2.3**
	ns	48″	**nd**	48″	**nd**	48″	**trace**
	ns	60″	**nd**	60″	**nd**	60″	**nd**
	ns	72″	**nd**	72″	**nd**	72″	**nd**
Soil Total	**12.4%**		**64.1%**		**48.5%**		**9.7%**

ns = not sampled

nd = not detected

Study #2:

The second study was initiated in 1988 to meet part of the reregistration requirements for Tordon. A site on Big Flat (northwest of Missoula) was selected to represent "worst case" conditions for Tordon applications. Supplemental irrigation was applied to ensure 125% of the long term average annual precipitation. Tordon was applied at 2 quarts (1 lb. a.i./ac.) in the spring of 1988. Vegetation, soil, soil pore water, and groundwater were measured from June, 1988 through November, 1990.

Results indicated that residues of Tordon were limited to the top 24 inches of soil 110 days after application with the highest concentrations in the upper 6 inches of soil. Residue levels 846 days after application averaged 9.7% of applied and were generally limited to the top 36 inches of soil. Tordon was not detected in groundwater above instrument quantitation limits (.1 ppb).

A review of site characteristics and results is shown in the following tables and figures.

Figure 3 illustrates the results from the Big Flat study. Numbers are shown as percent applied. On the day of application (0 day), residue of Tordon is concentrated on the vegetation (87.6%) and soil surface. After 3.5 months, most of the Tordon has moved from vegetation and is concentrated in the top 6 inches of soil (56.9%) with relatively low levels down to 24 inches. Twelve months after application, approximately 50% of Tordon had degraded and the highest concentrations occurred in the upper 12 inches of the soil profile. The last sampling date (28 months), indicated that 90% of Tordon had degraded and very low amounts were concentrated in the upper 36 inches with a trace (below quantified limits of detection) measured within the 36 to 48 inch depth.

Comparison of Studies

Environmental conditions and application rate are important factors influencing herbicide movement. ***Figure 4*** compares movement of Tordon in soil when applied at 2 qt./ac. at two locations. The highest concentrations of Tordon were located in the upper 5 to 6 inches and degradation rates were similar between the two sites. However, Tordon had moved to a greater depth in soil at the North Fork site (40 in.) than at the Big Flat site. This could be the result of high initial soil moisture content at North Fork.

Figure 5 compares Tordon applied at 1 pint and 2 qt./ac. 90 days after application. The amount of Tordon

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Figure 4: Percent of Tordon Remaining in Soil 90 Days Following Application of 2 qt./A at Two Locations.

North Fork*		Big Flat	
5″	37.1%	56.9%	6″
10″	14.2	2.4%	12″
20″	5.9	0.5	18″
30″	6.6	4.25	24″
40″	6.9	nd	36″
Soil Total	70.7%	nd	48″
		Soil Total 64.1%	

*Peter Rice Study, University of Montana

Figure 5: Comparison of Residue Levels (in ppb) of Tordon 90 Days After Application at Three Locations in MissoulaCounty.

Big Flat 2 qt/A		North Fork* 2 qt/A		Fort Missoula 1 pt/A
278	6″	205	5″	23
10.8	12″	94	10″	22
2.5	18″			
		20	20″	7
0.8	24″			
		22	30″	nd
nd	36″			
		24	40″	nd
nd	48″			

Figure 6: Summary of Residue Levels (ppb) of Tordon in Soil at Two Locations. Two Application Rates, 3, 14, 28 Months After Application

Fort Missoula 1 pint/A	
3 Month	**15 Month**
Soil Surface	
10 in. (22)	10 in (8-11)
20 in. (7)	Not Detected
Not Detected	
11 ft.	11 ft.

Big Flat 2 quarts/A		
3.5 Month	**14 Month**	**28 Month**
	Soil Surface	
(278)	(69)	(11.3) 6 in.
(10.8)	(28.8)	(6.3) 12 in.
(2.5)	(3)	(10.3) 18 in.
(2.0)	trace	(7.3) 24 in.
Not Detected	Not Detected	(5.5) 36 in.
		trace 48 in.
		Not Detected
11 ft.	11 ft.	

Shallow Groundwater

remaining in soil is shown in parts per billion (ppb) rather than percent of applied to allow for comparison between different rates (Note: an initial application rate of 1 pt./ac. would be equivalent to 250 ppb in the top 6 inches of soil). Application rate influences the degradation time and depth of movement in soil. Note the difference of residue levels between the 1 pint and 2 quart application rate.

Conclusion:

Figure 6 is a summary showing the difference in soil movement and degradation between two application rates and two locations. Even at the 4 pt./ac. rate, movement was generally limited to the top 36 inches and a 7 foot buffer remained between trace levels of Tordon and the shallow groundwater. Based on results from these studies it can be concluded that Tordon can be applied on most range and pasture sites without effecting groundwater quality.

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