TechLine

Information for Noxious Weed Control Professionals

January, 1990

Effects Of Spotted Knapweed On Soil Erosion

"False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for everyone takes a salutary pleasure in proving their falseness."
... Charles Darwin

by John R. Lacey, Extension Range Management Specialist, and Clayton B. Marlow, Associate Professor, Montana State University

Runoff was collected and measured at each plot. Shown is a collection at a grass-dominated plot.

The influence of spotted knapweed on the elements of erosion surface runoff and sediment yield was evaluated in western Montana. Comparisons were made on paired plots under simulated rainfall conditions. Runoff and sediment were 56% and 192% higher, respectively, on the knapweed-dominated, rather than the bunchgrass-dominated plots. It was concluded that spotted knapweed invasion into bunchgrass rangeland of western Montana was detrimental to the objectives of protecting topsoil and conserving water.

Introduction: Spotted knapweed (*Centaurea maculosa*) has invaded about 4.7 million acres of range and pasture land in Montana. This invasion has caused ranchers and other land managers to be concerned about the possibility of increased soil erosion. This report evaluates surface runoff and soil erosion on sites dominated by either spotted knapweed or native bunchgrasses.

Methods: The study was conducted northwest of Garrison, Montana, on the Bill Murphy Ranch. Annual precipitation averages 13 inches and elevation averages 4,450 feet. Soils were fine-loamy, mixed frigid, Typic Ustochrepts, and loamy-skeletal, mixed, Aridic Haploborolls. Slopes ranged from 13 to 37%.

Bluebunch wheatgrass (*Agropyron spicatum*), spotted knapweed, rough fescue (*Festuca scabrella*), prairie junegrass (*Koeleria cristata*), hoods phlox (*Phlox hoodii*), Idaho festuca (*Festuca idahoensis*)

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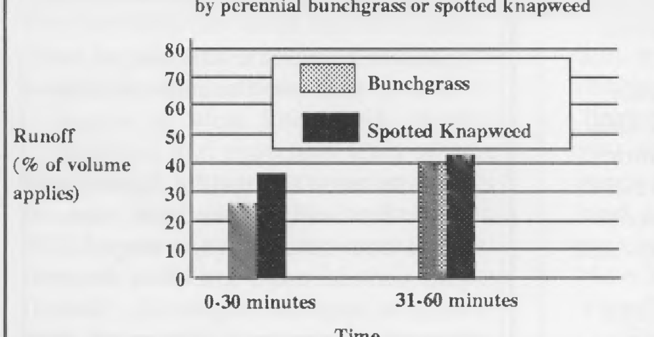
Figure 1 - Average surface runoff from range ,dominated either by perennial bunchgrass or spotted knapweed



In This Issue...

Welcome to another issue of TechLine. As Technical Service and Development (TS&D) representatives for DowElanco, we serve a vast geography. We enjoy the opportunity of coordinating scores of projects with an expanding number of scientists and researchers.

Thus, we created this newsletter to more efficiently supply information about our common work as well as explore your questions more thoroughly. TechLine provides a refreshing forum for successes specific to our region.

We want to answer your technical questions about our products and other aspects of well-planned weed control programs. Are there certain questions that always come up about our products that we should address? Do you have questions concerning groundwater, herbicide toxicity to fish or birds, or the dissipation characteristics of certain compounds? If you have a research project or successful weed control project you would like to share with our readers -- your colleagues -- we welcome them.

We use the DowElanco Billings, Montana, office as a central clearing house for TechLine information.

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"Erosion"

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and lupine (*Lupinus* spp.) were common species in the study area. The area was lightly grazed by cattle in the spring of 1987 and rested during summer and fall.

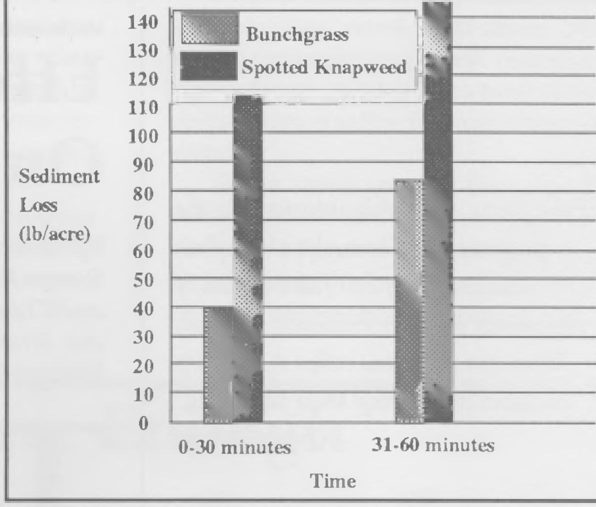
Paired-plots were located at 12 study sites. Percent slope, soil, and range site characteristics were similar between members of each pair; however, vegetation differences existed. Bunchgrasses produced about 90% of the herbage on one plot of each pair, while spotted knapweed contributed about 90% of the herbage on the other.

A modified Meeuwig Rainfall Simulator was used to apply a controlled, consistent volume of rainfall to 26-inch X 26-inch plots. Rainfall was applied during two consecutive 30-minute periods. Vegetation was clipped at a 0.5-inch stubble and removed before the second 30-minute application. Resultant overland flow was collected and measured, and the amount of sediment in the runoff calculated (**Figure 1**).

A modified Meeuwig rainfall simulator used in the study.

Results and Discussion: Total runoff from the initial 30-minute rain on grass-dominated sites averaged 23% and varied from 3 to 49% of the total volume applied (**Figure 1**). Runoff from the knapweed-dominated sites was significantly higher ($p < 0.10$). It averaged 36% and varied from 1 to 67% of the total volume applied (**Figure 1**). Although runoff increased during the second 30-minute run, differences between knapweed-and grass-dominated sites were not significant ($P > 0.10$).

Figure 2 - Average sediment loss from range dominated either by perennial bunchgrass or spotted knapweed.



Sediment yield was significantly less ($p < 0.10$) on grass-dominated rather than on knapweed-dominated sites. Sediment averaged 39 lbs/ac from grass sites and 114 lbs/ac from knapweed sites during the initial 30-minute run. Sediment loss increased during the second 30-minute run (**Figure 2**). Herbage production averaged 1,201 lbs/ac on grass sites and 1,065 on the knapweed sites.

Total runoff nor soil erosion appeared to be directly influenced by total herbage production. Instead, sediment eroded from a site increased with percent slope, amount of bare ground, and with the loss of plant material (litter). In general, there was more bare ground on the knapweed plots than on the grass plots.

Summary: The influence of spotted knap-weed on surface runoff and sediment yield was evaluated. Surface runoff and sediment yield during the initial 30-minute application were significantly higher on the knapweed plots than on the grass plots. Differences between knapweed and grass plots were not significantly different during the second 30-minute run. It was concluded that spotted knapweed invasion into bunchgrass rangeland of western Montana was detrimental to the objectives of protecting topsoil and conserving water. ◆

Successful Weed Control Requires Planning Your Work And Working Your Plan

The following section is an excerpt directly from the *Noxious Weed Management Planning Guidelines Workbook.* In this and following issues, we would like to re-emphsize using this weed management tool by going over sections which demonstrate just how planning facilitates noxious weed control. Those of you who have workbooks may refer to your own copy and follow along.

Anyone who does not have a copy of the *Noxious Weed Management Planning Guidelines Workbook, Vol. II* may order one or received extra assistance with the workbook by contacting: Ag West Communications, 2305 Nottingham Ct., Ft. Collins, CO 80526.

Why Does Planning Work?

There are at least seven reasons why weed management planning works:

1. Planning will improve your range and pasture weed control knowledge.

2. Planning saves you time and money and increases your satisfaction from your weed control efforts.

3. Planning forces you to think about and evaluate all the factors that affect successful range and pasture noxious weed control. More about these factors follows.

4. Planning helps you visualize your **total** weed problem, not just the one or two areas where you currently feel you have the greatest problem. The use of a good mapping system will tell you more about your land and the weeds out there.

Mapping also gives you an historical weed infestation record so you can easily assess the success of your weed control program.

5. Planning **prioritizes** your control efforts. You want to control infestations so as to produce the most economical results in the shortest time possible. Most of you manage extensive areas of range and pasture land. You should begin your control efforts in those pastures or units that will give you the MAXIMUM economic and/or weed control gains.

6. Planning creates a record keeping system that will maximize your effort and dollars invested.

7. Planning enables you to participate in state, county, or local weed control projects that benefit everyone by bringing the entire weed problem under control and stopping an infestation before it starts.

It is only through coordinated planning that an individual landowner or manager can successfully work with other landowners or managers, townships, counties, state, and federal weed control efforts.

How Does Planning Save Money?

A weed control plan for your farm, ranch or the lands you manage pays off in several areas. You experience greater success in controlling the weeds. You shorten the time it requires to stop knapweed, thistles, toadflax, and especially leafy spurge, although killing this weed is a multi-year effort even with the best plan. And you cut your costs since re-treatment rates are often lower and you won't waste chemical and time treating areas that don't require spraying.

Planning also helps you budget and anticipate cash flow. It isn't necessarily how much you spend on your weeds, but how successfully you spend it. Your plan should be a record keeping system to track spray treatments and rates **each year**, so that you can accurately and economically re-treat in following seasons until the weeds are controlled.

What Weed Control Factors Can Planning Help You Identify?

A plan will lead you to think about more than the weeds, however. Maybe your weed problem originates on adjoining property and even if you clean up your place, it will be quickly re-infested. If this is the case, then your analysis prompts you to obtain cooperation from adjoining landowners, whether they are private owners, public agencies, or a company, to treat their weeds.

Or your plan might reveal that most of your weeds inhabit rough, hilly terrain. Then a first step might be participation with other landowners to hire a private applicator to spray your rough terrain. Helicopter application in rough terrain has proven highly economical for landowners who form cooperative projects and treat large blocks as one spray job. Planning helps you determine if such an application method is a viable "factor" for your situation.

The types of weeds infesting your land, soil types, annual rainfall, sources of infestation, and what types of trees or alternate vegetation are present are all "factors" that must be considered if you are to successfully complete a range weed control program on your land.

How Does Planning Help Visualize Your Weed Problem?

Planning helps you visualize your weed problem because a weed control

See "Planning" on page 6

How Does Planning Increase Your Weed Control Knowledge?

When you know **WHAT** needs to be treated...
When you know **THE BEST METHODS** for treating...
When you know **WHEN** you treated...
When you know **WHERE** you treated...
When you know **WITH WHAT MATERIAL** you treated...
When you know **WITH WHAT RATES OF THE MATERIAL** you treated...
When you know **WHEN, WHERE, WITH WHAT MATERIAL and WITH WHAT RATES OF THE MATERIAL** you re-treated your infestations....

Then you will be using your time, hired labor, cost-share resources, equipment, grazing, biological control supplements, and herbicides to **maximum** economic benefit.

TORDON 22K Herbicide: Plant Activity And Environmental Fate

by Mark A. Peterson, Ph.D.
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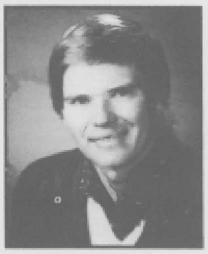
Brookings, SD



To correctly manage herbicides in successful integrated weed management programs, it is important to understand how they work and their environmental impacts. This article details how TORDON* 22K herbicide, which contains the active ingredient picloram, works to control certain broadleaf weeds and what happens to the herbicide in the environment.

Plants produce numerous compounds which impact growth. Examples of this include indole acetic acid (IAA), auxins, and cytokinins. The first report of picolinic acid with plant inhibitory properties was made in 1908. Scientists noticed an infertile soil area and on further investigation isolated the compound, picolinic acid. Some fungi produce fusaric acid which is structurally similar to the active ingredient, picloram, in TORDON 22K and causes some of the same symptoms as TORDON 22K on plants. Picloram was developed into a usable compound, TORDON 22K, and has been marketed since 1963.

How TORDON 22K Works: The target for TORDON 22K herbicide's activity encompasses broadleaf plants. The molecule has an extremely low toxicity to animals but maintains the ability to effect plants at extremely low rates. For instance, some species, such as wild buckwheat, are controlled with as little as 1.0 fluid oz./acre of TORDON 22K. TORDON 22K remains highly selective to grasses. Most grass species are tolerant to rates greater than 1 gal/acre. Some species such as smooth brome (*Bromus inermis* L.) may exhibit some stunting at these rates.

The mode of action for TORDON 22K is as a growth regulator. TORDON 22K mimics natural plant auxins. Once inside the plant, the molecule upsets the normal pace and organization of plant growth. The result is epinasty -- excessive growth along one side of the plant causing it to bend downward. Internally, this abnormal growth crushes and disrupts vascular tissue causing death of the plant. Not isolated to a particular location, TORDON 22K may work at many sites of action within the plant making it less likely that weeds will develop resistance. TORDON 22K is also less subject to metabolism in plants than other growth regulator-type herbicides. This may account for its greater activity at low rates.

Factors Affecting Plant Uptake: In order for TORDON 22K to work, the molecule must be absorbed into the plant. Drought and other extreme environmental conditions change the thickness and nature of the plant cuticle making herbicide absorption more difficult. Warm temperatures and high humidity result in optimum absorption. High humidity hydrates the plant cuticle which provides a better penetration pathway for water soluble herbicides such as TORDON 22K. Warm, humid conditions allow maximum opening of leaf stomata which provide additional pathways for herbicide entry.

Photodegradation of Some Herbicides

Herbicide	Photodecomposition
TORDON 22K	**5-20 days**
CURTAIL	**very slow**
BANVEL	**nil**
2,4-D	**very slow**

Incorporating adjuvants in herbicide applications, such as crop oils, surfactants, fertilizers, etc., act primarily in two ways. The additives serve to reduce spray droplet surface tension and increase contact between the herbicide solution and the leaf. The adjuvants also alter waxes present on the plant cuticle or even alter the permeability of cells within the leaf. This makes herbicide penetration easier. However, some adjuvants may damage plant leaves to such an extent that herbicide translocation out of the leaf and into the entire plant is retarded.

Absorption of TORDON 22K is not limited to uptake through plant portions above the soil. TORDON 22K can be absorbed by roots, too. Soil residual and root uptake are important for control of seedlings of perennial plants. Researchers disagree about the importance of soil residual and root uptake in control of established perennials.

Movement Within The Plant: The pattern of translocation for TORDON 22K addresses all functions of the plant. TORDON 22K is readily transported in both the phloem (food-carrying portion of plant vascular system) and the xylem (water and mineral carrying portion). This movement through the plant provides complete control of the plant. Some herbicides are transported mainly in the phloem (e.g. glyphosate) or maily in the xylem (e.g. atrazine).

The extent of translocation is dependent upon growing conditions. Good growing conditions cause increased production of photosynthate. In perennials, this usually results in more flow of sugars to the roots for storage. Phloem-mobile compounds such as TORDON 22K will move with these sugars to the roots. Hot, dry conditions not only reduce photosynthate production but also increase transpiration which may result in movement of translocated TORDON 22K out of the roots back to the upper portions of the plant.

Several herbicides are known to be exuded from the roots of perennial plants. In one study 60% of the TORDON 22K translocated to leafy spurge roots was exuded. This exudation is passive and probably cannot be altered.

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TORDON 22K Herbicide In The Environment: Photodecomposition of TORDON 22K by the ultraviolet (UV) rays in sunlight occurs in water, on the soil surface, and on plants. UV light can degrade 100 ppm to 0.5 ppm in 30 minutes in distilled water. Degradation by sunlight in natural waters is slower. Rate depends on water clarity and sunlight intensity. In clear water complete decomposition may take from 7 to 22 days.

On the soil surface, degradation rates are much slower than in water. Lab studies indicate 15% breakdown in one week under sunlight on a soil surface, as compared to 65% breakdown on a glass surface under the same conditions. Once incorporated into the soil TORDON 22K is not significantly photodegraded.

At one Montana location 44% of the applied TORDON 22K herbicide was photodegraded. At a similar treatment site, rainfall washed the chemical into the ground and photodecomposition did not contribute any significant amount.

Not much information is available concerning photodecomposition on leaf surfaces. The process is thought to be much slower than degradation in water. It is probably similar to or slightly higher than loss on soil surfaces.

TORDON 22K is degraded beneath the soil surface in several different manners. Microbial degradation is incidental since microorganisms involved do not directly use TORDON 22K as a food source. TORDON 22K is degraded by the enzymes produced to breakdown soil organic matter. However, a given soil can only degrade a fixed amount of TORDON 22K over a given period of time. The soil's microbial population cannot adjust to increasing rates of TORDON 22K. Therefore, the half-life of TORDON 22K in soil increases as the rate of application increases.

Organic matter in the soil, on the other hand directly influences the rate of breakdown. More organic matter causes more microbial activity and more TORDON 22K breakdown.

Vapor Pressure Comparisons

Pressures measured in millimeters (mm) of mercury (Hg)
(Compounds are listed in descending order with the least volatile material listed first.)

Herbicide	Vapor Pressure (mm Hg)
TORDON 22K	6.8×10^{-7}
2,4-D acid	6.0×10^{-7}
GLEAN	4.6×10^{-6}
BANVEL	3.41×10^{-5}

In this chart, the smaller the number, the less volatile the compound. A value of 10^{-7} is less than a value of 10^{-6}. The values listed are for technical material of each compound. Formulated versions *can* have different values than technical materials. However, the formulated version of TORDON 22K is still less volatile than the formulated version of BANVEL, for instance.

Warm soil temperatures and moisture levels near field capacity result in optimum aerobic microbial activity which in turn results in optimum TORDON 22K degradation for a given soil.

Decomposition in water, other than photodegradation, is slow.

Off-target Movement: TORDON 22K has a low vapor pressure (6.8×10^{-7} mm Hg), thus categorizing it as having a low volatilization. Vapor drift is not considered a problem with the potassium salt formulation (22K). As with all herbicides, particle drift onto sensitive species is a potential problem.

Runoff is one concern for herbicide movement. Research indicates a maximum of 3-4% of applied TORDON 22K is moved off an application site by runoff water. At high rates of application this may be enough to damage sensitive plants which occur short distances downslope. A buffer zone of untreated ground cover, such as sod, should prevent significant amounts of TORDON 22K from moving off-site.

Potential problems with leaching depend upon sorption, degradation rate, and permeability of the soil. TORDON 22K sorbs or binds to soil organic matter. Organic matter resides in the top several layers of soil. The binding of TORDON 22K and organic matter increases with time.

For example, if an area were treated with TORDON 22K and then it rained, TORDON 22K is more likely to move from the treated area. If an area were treated, though, and it rained a week or two after the application, TORDON 22K would be less susceptible to movement. TORDON 22K would have had 7 to 14 days to bind with the organic matter in the soil and keep it in place. Laboratory tests have classified TORDON 22K as moderately to highly mobile in soil. However, at lower application rates TORDON 22K will probably decay before moving past the upper levels of the soil. Under North Dakota conditions (relatively slow degradation) a North Dakota State University study showed TORDON 22K did not move below the top 24 inches of soil at rates less than 1 qt/acre. ◆

Parts Per Billion... Parts Per Trillion...

We often find reference to "parts per billion" or "parts per trillion" in regard to trace contaminants in chemicals. What is apart per billion? How big is a part per trillion? Are they a lot, a little bit?

Well, if you're 32 years old, the equivalent of a part per billion would be 1 second out of 32 years. A part per trillion is 1 second out of 320 **centuries**!

For you big spenders, the equivalent would be one penny out of $10 million, and a part per trillion would be one penny for every $10 billion.

Part Per Billion

- 1 square foot/36 square miles
- 1 bad apple/2,000,000 barrels
- 1 pinch of salt/ 10 tons of potato chips
- 1 bogey/3,500,000 golf tourneys

Part Per Trillion

- 1 square inch/250 square miles
- 1 bad apple/2,000,000 barrels
- 1 pinch of salt/10,000 tons of potato chips
- 1 bogey/3,500,000,000 tourneys
- 1 flea/360,000,000 elephants

We hope this will be useful in helping you keep discussions of parts per trillion in their proper perspective. ◆

"Planning"

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plan requires a map. Many counties in North Dakota, Montana, Wyoming and Colorado now systematically map their weed infestations. Obtain ASCS, SCS, or even aerial maps of your operation and you can quickly get a weed control mapping plan underway.

How Does Planning Prioritize Your Control Efforts?

Your plan helps prioritize the most important pastures or areas on your property that need spraying. There are many factors involved here, but a plan will define and sort out what should be sprayed first. For example, it only makes sense to treat the top end of a watershed first. Starting at the bottom is like pushing water uphill.

What Record Keeping Is Required?

Basically a plan involves a record of what types of weeds infest your property, their location, what priority you attribute to the infested land, and information about the correct treatment methods, chemicals to use, biological control supplements, and the best time to use them. Your plan should also contain an assessment of control results, as well as a year-to-year re-infestation record and a record of re-treatments.

There is tremendous value in these records. Yearly records will help maximize the dollars and labor you invest in noxious weed control. They help you chart progress as well as show you where additional work is needed. And records invaluably assist you in budgeting an effective multi-year plan that even your lender or land management superiors will support.

Why Is Planning Necessary To Participate In A Cooperative Project?

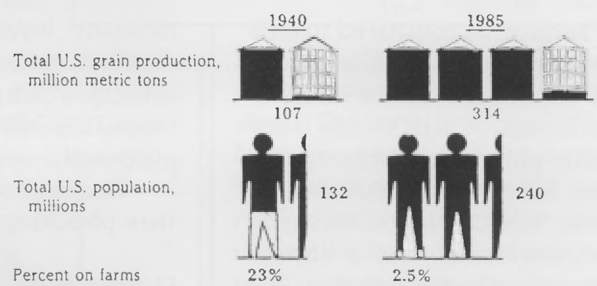
Public officials who administer our noxious weed cost-share programs are beginning to ask that counties and even landowners have a plan before they qualify for cost-share assistance.

Some states require that you develop and submit a weed management plan for approval to qualify you or your project for cost-share funds or other governmental assistance. ◆

Can Organic Farming Produce Enough Food To Feed Us?

If we were to use more manpower to produce food, rather than new technology, we would have to put about 52 million people back on the farm to reach the 23 percent farm population of 1940 (**see chart**).

For comparison between 1940, prior to modern pesticides, and 1985



Limitations on "natural" pest control include: some bugs found in California and elsewhere do not have natural predators (e.g. other species of "good" bugs) that feed on them; natural predators may not be present in great enough numbers or may not work fast enough to control a rapidly reproducing bug population, whereas the appropriate chemical can work immediately; and some plant diseases and weeds do not have "natural" controls.

Increasing fruit and vegetable production to allow Americans to double their intake of produce, as recommended in 1989 by the National Academy of Sciences to reduce the risk of cancer, would be impossible without predictable and effective pest control.

Sources: In Food Safety, Spring '89, Vol. 2, Iss. 2, Fresh Produce Council and Alliance for Food and Fiber. ◆

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