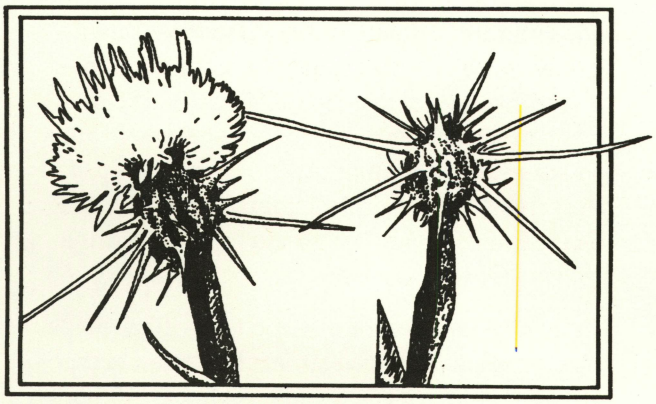


Yellow Starthistle Management with Herbicides

Robert H. Callihan and Lawrence W. Lass

THE PROBLEM

Recorded spread of yellow starthistle in various areas of the western states has ranged from 6 to 60 percent increase in infested acres per year. Nearly 500,000 acres are now infested with yellow starthistle in Idaho. The weed dominates nonarable annual grassland sites that receive less than 20 inches of precipitation per year, and persists in areas of even higher rainfall. Wherever downy brome (cheatgrass) grows, yellow starthistle appears to be well adapted. Treatment of roadside right-of-ways, industrial sites, and other high-use areas with herbicides helps retard the spread of this fast-moving weed, yet it continues to invade new lands.

HISTORICAL USE OF HERBICIDES ON YELLOW STARTHISTLE

Yellow starthistle has been treated with 2,4-D, MCPA, and other herbicides with plant growth hormone biochemical activity since the early 1960's. Dicamba, sold as Banvel, and picloram, sold as Tordon, came into use on yellow starthistle in the early 1970's. Since then, yellow starthistle has been declared noxious in most of the western states, and mandatory control has resulted in treatment of vast acreage. Yellow starthistle has been primarily a weed that infests land of low economic value. Investments for weed control on such land are not perceived to be recoverable; consequently little yellow starthistle control is done on such land. However, in recent years, yellow starthistle has begun to invade cropland. Contamination of alfalfa and other crop seed has resulted in long-distance invasion by yellow starthistle.

Changes in herbicide practices have allowed yellow starthistle to increase in some crops. Prior to 1980, small grains were treated with 2,4-D, MCPA, dicamba, and other plant hormone-type herbicides, and with bromoxynil, metribuzin, and other herbicides to which yellow starthistle is sensitive. Since then, use of sulfonylurea herbicides, which are generally not effective on yellow starthistle, has increased for weed control in cereal crops at the expense of the prior herbicide practices. After the advent of Glean and other sulfonylurea herbicides, the proportion of herbicides in use that were effective on yellow starthistle in cereals was generally reduced. These changes have allowed the weed to become more prominent in small grain crops.

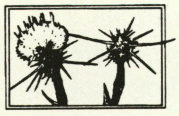
In rangeland, however, hormone-type herbicides, particularly 2,4-D, dicamba, and picloram have

University of Idaho
College of Agriculture
Cooperative Extension System ❖ Agricultural Experiment Station CIS 1036

been fundamental to yellow starthistle control. Designation of yellow starthistle as a noxious weed has encouraged adoption of cost-share programs in which state or county funds are contributed to the cost of herbicides used for noxious weed control, for the sake of public protection from noxious weeds. That has occasionally resulted in frequent treatment of some parcels of land.

In many cases, the condition of infested sites has not been appropriate for suppression of yellow starthistle because the site is susceptible to rapid reinvasion by yellow starthistle. When a site is occupied by an apparently solid stand of yellow starthistle, it is usually because the site was dominated previously by downy brome or some other annual grass as a result of prior overgrazing or abandonment of a cultivated field. The site was then susceptible to invasion by any species better adapted than the annual grass. That better-adapted species was yellow starthistle. Yellow starthistle is an annual, but can easily out compete annual grasses. It develops deep roots faster, grows taller, shades grasses with broad, spreading leaves, and stays green and growing longer into the summer, so yellow starthistle dominates the site. When yellow starthistle is temporarily removed by herbicide treatment, the annual grass regains dominance, only to lose the site again within two to three years to yellow starthistle that reappears from dormant seed or seed from a nearby source. Thus, herbicide application on such a site reduces yellow starthistle temporarily, not permanently. The result is usually short-lived, uneconomical control that discourages the landowner from further attempts to manage against yellow starthistle.

High-frequency use of a single type of herbicide tends to select for weed strains that tolerate that type of herbicide. The change is genetic, although it is neither mutation nor an acquired characteristic. Apparently, the genetic potential for resistance has always been in the yellow starthistle species, and has simply been concentrated by the process commonly known as "survival of the fittest." In at least one documented case in the Northwest, a yellow starthistle population became resistant to normal doses of the hormone herbicides 2,4-D, dicamba, and picloram. The tolerant type has apparently not spread from the site, and is not considered likely to do so, but development of resistance may be possible at other locations that have been treated in a similar way. Although yellow starthistle resistance to a herbicide has not yet become a widespread problem, the potential cannot be ignored.



Why haven't we gotten rid of yellow starthistle with herbicides?

Herbicide effectiveness is high, but for only a season or two after treatment. Although the effects of a herbicide may last much longer, the herbicide itself is only one of several factors that determine the ability of the treatment to provide long-term control of the weed.

Failure of any of the following elements will result in persistence and spread of yellow starthistle infestations:

1. *Control must be consistent and continuous.* If it is not, yellow starthistle will reinfest treated areas. A small proportion of the yellow starthistle seeds may survive in soil up to 10 years. Each year, some of the seeds will break dormancy and germinate. If the resultant seedlings are not prevented from flowering, they will produce a crop of seeds that will last another ten years.
2. *Management must be area-wide to prevent reinvasion of yellow starthistle into a clean area from adjacent land.* If one landholder does not control yellow starthistle on an infested property, seeds will migrate to adjacent properties by way of wind, animals, or by way of equipment and materials such as soil, hay, wood, seeds, and clothing. Reinvasion within an area is due to survival of seeds in the soil and/or local spread from nearby populations. If yellow starthistle on neighboring infested land is not controlled, no amount of management can protect adjacent property from invasion by seed from those neighbors.
3. *Control must be complete to prevent rapid reinvasion.* Herbicide application must be at the correct rate, applied at the correct time, and it must be applied uniformly. Many people treat yellow starthistle by applying a herbicide in amounts correct for the total area, but fail to apply it uniformly, or fail to apply the herbicide early enough to destroy the plants before they

become large enough to tolerate normal amounts of herbicide. Herbicides may suppress most of the population but will not prevent rapid resurgence of yellow starthistle in the management unit. Every treatment should be followed by an inspection within two weeks, and plants that escape should be removed or retreated.

4. *Small isolated colonies and right-of-way infestations must be destroyed before they expand to populate large areas.* If the first yellow starthistle plants in the Northwest had been destroyed and their location closely monitored for a few years, the present vast acreage would not exist. Human nature is such that weed problems are not given much attention until they cause economic impact, at which time they are so extensive and thoroughly entrenched that they cannot be managed except at high cost. Concern over weed invasion rises in proportion to the economic impact of the weed. Many people become so concerned with large infestations of yellow starthistle that they don't bother with the small patches. Technology to economically eradicate yellow starthistle populations that extend over hundreds of thousands of acres of nonarable land does not exist. Yellow starthistle is a prolific producer of long-lasting seeds, and is well adapted to survival on land that is of such low productivity that weed control is not a high priority management consideration. Vast infestations cannot can be eradicated; little colonies can. To do so requires documentation of their location and area to enable reliable monitoring over a period of at least 10 years.
5. *Biological control is imperative.* Weed control is not sustainable in a vacuum. The only proven biological control available for yellow starthistle in the United States is competitive vegetation. Removing yellow starthistle will allow low-value, weedy annual grasses such as downy brome, medusahead, or rattail fescue to dominate unless vigorous desirable vegetation is ready to compete with them. Annual weedy grasses cannot compete well enough to keep yellow starthistle down, so it reappears from dormant seed. Natural biological suppression by desirable perennial plants that do not have to compete as seedlings with the more vigorous yellow starthistle seedlings will greatly retard the return of dense weed populations. Without competition from a well-cared-for stand of desirable perennial grass, herbicide treatment alone is insufficient. Poor results from incorrect herbicide use simply turns the rancher against further use of herbicide for yellow starthistle. Biological suppression of yellow starthistle can be encouraged by first eliminating a season's yellow starthistle crop, followed by fertilization where appropriate, reseeding where feasible, selection of suitable grass species if reseeding is needed, and finally by well-managed grazing to minimize stress on perennial grasses.

WHAT ABOUT BIOLOGICAL CONTROL WITH INSECTS?

Research indicates that herbicides do not interfere with plant-parasitic insects of the kind tested for yellow starthistle. Such parasites should work compatibly with herbicides in an integrated management system. Several weed-specific yellow starthistle parasites are under test. A diversity of specialized yellow starthistle parasites may be necessary to cause control; no single species by itself has been shown to significantly affect the weed. Although five yellow starthistle-specific parasites (three seedhead weevils and two seedhead flies) have passed tests for safety to other U.S. plants, they have not yet resulted in satisfactory control of the weed in the United States. Evaluation of their effectiveness and recommendation for their use will depend on results of current research and development programs by the University of Idaho, the United States Department of Agriculture's Agriculture Research Service (USDA-ARS), and other researchers. If USDA-ARS and University of Idaho research continues to develop a diversity of new biological control parasites for yellow starthistle, weed-specific parasitism may eventually be the major factor in suppression of that weed, along with competitive vegetation.

Because the above principles generally have not been followed, yellow starthistle has expanded beyond the scope of eradication in some regions. Why have these principles not been followed?

1. The long seed dormancy has not been commonly recognized.
2. Where the weed is widespread and dominant in a region, area-wide cooperative management is organizationally difficult.

3. The human tendency is to be satisfied with tasks that appear essentially or virtually complete rather than complete.
4. Small, isolated individuals or colonies do not appear sufficiently threatening to warrant diligent action.
5. Effective biological control with parasites has not been developed for yellow starthistle yet, and biological control with competitive vegetation is not economically feasible in low-productivity sites.
6. Most managers avoid intensive management on low-productivity lands because it is perceived as too costly to be feasible. Nonetheless, the spread of yellow starthistle can be effectively minimized and excluded from properties that are yet uninfested, if proven principles of land management can be practiced. While these principles may be impractical where infestations are vast, they are both practical and advisable for small, new colonies of yellow starthistle in regions where it has not become widespread. They are necessary for responsible management of transportation corridors.

Can yellow starthistle be economically suppressed?

Integrated management practices can effectively suppress this weed on land accessible for management. Unfortunately, such practices are not economically feasible on all lands. Effective integrated management requires a planned approach that includes combining herbicide application with biological suppression. Competitive grasses will retard yellow starthistle reinvasion, although they cannot be expected to do so without managerial assistance. Some of the infested land can be planted with ground equipment. Where this can be done, the returns to investment often warrant herbicide application, replanting, fertilizing, and other management practices. Imported insects may eventually provide significant help. Distribute approved, weed-specific parasites when available.

Where the weed is widespread on land that is too inaccessible to follow the principles of yellow starthistle management with the intensity required to suppress it or protect other properties from the seed it produces, resources should not be wasted on futile efforts. In such cases, defeat should be acknowledged and resources diverted from yellow starthistle control to more productive goals. It may be best for the property to be declared a special management zone in which control of yellow starthistle is not required under the noxious weed law.

This does not mean that good management should be abandoned entirely. Proper use, even without great additional resource investments, may prevent the property from being further degraded.

What herbicides can be used?

Registered uses

Herbicides currently registered for use alone or in combination with other herbicides for yellow starthistle control include 2,4-D, dicamba, picloram, clopyralid, chlorsulfuron, diuron, and imazapyr. Not all are equally effective. These are discussed in more detail later in this bulletin. Even though yellow starthistle may be on the list of weeds controlled on a herbicide label, the herbicide label must show that the herbicide is registered for the site to which it is to be applied. However, even though the label may not include yellow starthistle on the list of weeds controlled, if the label permits application to the site of the yellow starthistle, the applicator has the option of using the herbicide for yellow starthistle. In this case, the manufacturer is not responsible for the effectiveness of the herbicide for that off-label use, so the applicator must assume the risk of success.

Weed condition

Regardless of the herbicide used, an individual yellow starthistle plant becomes increasingly tolerant to herbicides as the weed gains size. By the time the plant has begun to produce visible stems, it tolerates herbicides at the low end of the registered dose range, with a large percentage of plants surviving. By the time it forms flower buds, it is generally too late to kill the plant with economic rates of herbicide, although herbicides will reduce seed viability somewhat. If the vigor and growth of yellow starthistle stops because of drought stress or maturity, or is injured by something else, the herbicide is less likely to be effective on the weed.

Treatment with an herbicide as late as the early bud or early flowering stage may greatly reduce the number of seeds produced and the proportion of viable seeds, but will not reliably destroy the plants unless the dosage is much higher than that necessary to kill plants in the seedling and rosette stages. Lower dosages may stop seed production, however. If the current year's seed production is stopped or reduced, the yellow starthistle stand may be somewhat less dense the next year, but the plants may be larger and as prolific because of the reduced competition. Herbicides applied in midsummer are apt to degrade from sunlight, because rain is usually insufficient to move the herbicide into the soil. This prevents soil-active herbicides from persisting sufficiently into the fall to satisfactorily control fall-germinating yellow starthistle arising from dormant seed produced in prior years.

What kind of herbicide works best?

No herbicide is available for control of yellow starthistle under all conditions. Herbicides are registered for specific types of sites, so the best way to select a herbicide for any particular weed is to first find out what the options are for the site under consideration, then determine whether the allowable herbicide will control the weed. The way to determine what herbicides are permissible for a particular site is to consult an authoritative annual such as the Pacific Northwest Weed Control Handbook, the Meister publication, Weed Control Manual, or a licensed expert in weed control such as a county Extension agricultural agent, private consultant, or fieldman.

Base your selection of herbicides on these guidelines for specific types of sites:

Nonarable land

In nonarable land such as range, pasture, fence rows, storage yards, right-of-ways, and noncropland, a herbicide with long soil activity is desirable to minimize treatment frequency. Herbicides that act primarily through the leaves, or those with a short soil life (like 2,4-D or MCPA) may destroy all yellow starthistle plants present at the time of treatment, but will not control plants that germinate later. Herbicides (like diuron) that enter plants through the roots should be applied prior to late winter or early spring rains to ensure destruction of existing rosettes before they grow large enough to tolerate normal herbicide doses. Herbicides (like picloram or dicamba) that enter the plant through both leaves and roots should be applied after most seedlings have emerged but are still small enough to succumb to low herbicide doses. Late winter or early spring application is best for control of seedlings that emerge later in the spring whenever the soil is sufficiently moist and warm for seed germination. Such spring-germinating plants may produce serious infestations, and may become larger than normal because of reduced intraspecific competition. This results in a large seed crop that can completely renew the reserve of yellow starthistle seeds in the soil.

Small grains

For yellow starthistle control in annually planted cropland such as small grains, the herbicide should generally have foliar activity with little or no soil longevity, or a short soil residual life, to avoid injury to crops in rotation. It must be selective enough that the crop will not suffer a significant loss in productivity or quality from herbicide effects. Directions on labels of herbicides registered for small grains specify how to use the herbicide without incurring such crop damage. Most small grain weed control management programs that include crop rotation, tillage, and a diversity of herbicides over the course of the crop rotation will maintain suppression of yellow starthistle along with the more significant weeds of those crops. Application of chlorsulfuron and other sulfonylurea herbicides registered for and widely used on small grains does not affect yellow starthistle, so an additional herbicide mixed with the sulfonylurea herbicide is necessary to control yellow starthistle.

Perennial crops

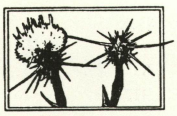
Densely planted perennials are seldom troubled with yellow starthistle until the field is disturbed. However, when stand density is reduced or the soil is disturbed by animals or equipment, or plants die to leave open spaces, weeds such as yellow starthistle may invade. For perennial crop species on land that is replanted only occasionally, a long period of herbicide soil activity is desirable. Alfalfa fields, for example, can be treated in the late fall or winter with a soil-active herbicide, to control seedlings in their smallest and most susceptible stages when low concentrations of herbicide are effective. If the field is treated for emerged yellow starthistle seedlings when the alfalfa has resumed spring growth, the herbicide must be one that does not damage the crop foliage, yet potent enough to destroy well-emerged, yellow starthistle seedlings and well-developed rosettes.

On most sites, yellow starthistle is not the only weed. It is generally desirable to control other weeds in addition to yellow starthistle. A herbicide or herbicide mixture that controls a wide range of weed species without damage to any of the desirable species on a site is better than one that has a limited range of activity. If a perennial crop has a significant problem with yellow starthistle or other annual weeds throughout the field, the potential productivity of the stand is likely affected more by the loss of crop plants than by weeds. The advisability of renovating the stand by replanting should be considered before deciding to apply a herbicide over the entire field for control of yellow starthistle. Where alfalfa, perennial grasses, or other crops are grown for seed in arid regions, the crop may not have the natural ability to maintain a stand density sufficient to exclude annual weeds such as yellow starthistle, and herbicides may be necessary. When patches of weeds occur in a field, it may be best to treat only those spots rather than the entire field.

How effective are the herbicides labeled for yellow starthistle?

Appearance of yellow starthistle on a herbicide label does not mean that this weed will be controlled in all of the sites for which the herbicide is registered. Herbicide doses sometimes vary according to the site, and the weed's growth habits are affected differently by different types of sites and site management. Some herbicides are effective on yellow starthistle at doses that are selective within crops, whereas other herbicides are effective on yellow starthistle only at nonselective doses.

Choice of herbicide depends on the need for selectivity, the degree of soil activity, the type of site, the growth stage of yellow starthistle, and the reason for which the treatment is to be applied, i.e. whether for short-term weed kill or for a long-term program of planned management.



WHICH HERBICIDES ARE BEST FOR YELLOW STARTHISTLE CONTROL?

All product label precautions must be followed prior to using a herbicide or planting susceptible plant species or crops on treated sites. The following herbicides specify yellow starthistle on the labels by certain manufacturers. Do not select a herbicide brand that is not labeled for yellow starthistle unless you have prior experience and knowledge that it will work, for there is no manufacturer's assurance that the herbicide will work on that weed if it is not listed on the label.

Whereas the generic herbicide may be effective in some formulations, the particular brand you select may be formulated differently to reduce its effectiveness on yellow starthistle. Because herbicide registrations change continually, some may be eliminated after publication of this bulletin, and some new registrations may be added. You can keep current by consulting the periodicals and people mentioned earlier.

PLANT GROWTH HORMONE HERBICIDES

Natural plant growth hormones determine the growth, shape, and function of a plant and its parts. Plant growth hormone herbicides have chemical structures similar to natural plant hormones, and affect plant cells in much the same manner that natural hormones do. They do so in a less organized manner, however, so that plant functions are disrupted to cause plant death.

2,4-D (certain trade names) or **MCPA** (certain trade names)

Selectivity
These herbicides are effective for control of a wide range of broadleaf plants including many species in the mustard family, but grass species are tolerant.

Soil activity
These herbicides provide not more than 2 weeks for suppression of yellow starthistle seedlings.

Growth stage
Seedlings are susceptible to low doses. When control has been delayed into the mid to late spring and yellow starthistle rosettes are large or bolting, use 2,4-D at or near the maximum labeled dose to suppress or destroy large plants. It has good foliar activity on yellow starthistle, and has enough soil activity and longevity to stop emerging seedlings for two weeks after the herbicide is applied.

Type of site
2,4-D is registered on a variety of crops including small grains, fallow, CRP, range and pasture, as well as forestry and non-crop sites. MCPA is registered for use in some legume crops, including alfalfa.

Management objective
These herbicides provide selective, short-term control for the least cost. For good season-long control, more than one application per year is generally needed, because yellow starthistle seedlings that emerge after treatment often survive and produce seeds. Repeated applications of these low-cost herbicides may be more costly than single applications of longer-lasting but more expensive herbicides.

DICAMBA
(Banvel and other trade names)

Selectivity
Dicamba controls a wide range of non-grass species, but is relatively weak on members of the mustard family. Mixtures with 2,4-D or other herbicides can overcome this. Dicamba can be absorbed by plant foliage or roots, and controls late-emerging yellow starthistle seedlings for a month or more after treatment.

Soil activity
Dicamba will usually control emerging seedlings for up to a month or more after application, depending on rate applied.

Growth stage
Best activity is obtained on emerged plants in the seedling stage. For best overall control with dicamba, apply it when most plants are in the early rosette stage (before bolting). Later applications may be successful if 2,4-D is added.

Type of site
Banvel is registered on a variety of crops including small grains, fallow, range pasture, and non-crop sites.

Management objective
Dicamba provides selective control for a single growing season if applied early.

Picloram
(Tordon 22K and other trade names)

Selectivity
Picloram is active on a wide range of non-grass species, but relatively weak on members of the mustard family. Mixtures with 2,4-D or other herbicides can overcome this. Perennial grasses tolerate herbicidally-effective doses, although they may bend over, or recline, in response to high doses.

Soil activity
The high label rates will usually control emerging seedlings for up to 3 years after application, depending on environmental conditions and rate applied. Picloram at 0.25 lb active ingredient per acre (one pint per acre) is seldom sufficient to suppress yellow starthistle seedlings for more than 2 years in the Pacific Northwest. However, when perennial grass is released from yellow starthistle domination for a 2-year period, competition will retard reinvasion by the weed for many years after the herbicide has biodegraded.

Growth stage
Pre-emergent control is possible provided 1/4-inch or more of precipitation occurs after the application and before plant emergence. Registered doses of picloram are most effective on emerged plants when seedlings are small, but will kill or stop plant growth if applied up to the time the plant reaches the bolting stage, i.e. when upright stems are visible. Application for yellow starthistle control is effective any time during the fall, winter, or spring even though seedlings may not be emerged. For application to plants in the bud stage, addition of 2,4-D increases herbicide treatment effectiveness.

Type of site
Picloram is registered for use on several crops including small grains, fallow, CRP, roadside, fence rows, range, pasture, forestry, and non-crop sites.

Management objective
This herbicide provides selective, long-term control often lasting for two or more seasons, with a single application. It is particularly useful when costs of application and follow-up inspection and treatment are high, when there is no off-target hazard or where annual herbicide applications are not advisable.

Limitations
Picloram can persist in the soil at sub-lethal levels for a year or more, and can damage sensitive crops if they are planted before the herbicide degrades. At doses that control yellow starthistle, picloram is not highly effective on weeds of the mustard family.

Clopyralid
(Stinger; Transline; Curtail, which is a mixture of clopyralid and 2,4-D; and Curtail M, which contains MCPA in addition to clopyralid.)

Selectivity
Clopyralid is highly active on a narrow range of broadleaf plants including thistle and legume species. Grasses and a wide variety of broadleaf species will tolerate normal doses of clopyralid. Mixtures with 2,4-D broaden the spectrum of activity.

Soil activity
Will usually control emerging seedlings for the season of application, depending on rate applied.

Growth stage
Best activity is obtained on emerged yellow starthistle from the seedling stage until bolting, when upright stems are visible. Later applications are successful if 2,4-D is added.

Type of site
Stinger and Curtail are registered on a variety of crops including small grains, fallow, CRP, range and pasture, and non-crop sites. Transline is registered for use on range, pasture, coniferous forest sites, wildlife openings and non-crop sites. Transline is the only herbicide useful for yellow starthistle that is suitable for application over the top of conifers.

Management objective
Clopyralid provides selective, season-long control. Long-term control can be obtained with annual treatment. The cost of a clopyralid application may be equivalent to two or more applications of a lower-cost, but short-lived herbicide. Clopyralid is weak on plants in the mustard family, but very effective on a wide range of species, particularly those in the sunflower family, including yellow starthistle.

These herbicides inhibit formation of branched-chain amino acids that are present in plants but not in animals.

CHLORSULFURON
(Telar)

Selectivity
Chlorsulfuron is active on a wide range of non-grass species. Grasses tolerate cropland rates of chlorsulfuron, but those rates are insufficient to kill yellow starthistle.

Soil activity
At sufficiently high rates, chlorsulfuron may control seedlings for 2 to 4 weeks after treatment.

Growth stage
Chlorsulfuron provides control when applied pre-emergence (before the weed emerges), or post-emergence when seedlings are small.

Type of site
Telar is registered for control of yellow starthistle on non-crop industrial sites.

Management objective
Chlorsulfuron is considered very weak on yellow starthistle, but it can control yellow starthistle on sites where destruction of all vegetation is acceptable. It is not the herbicide of choice for yellow starthistle control, but will control that species as a secondary objective when used at high rates for other management objectives.

IMAZAPYR
(Arsenal; Topsite—a mixture of imazapyr and diuron.)

Selectivity
Imazapyr does not provide selective control of yellow starthistle.

Soil activity
Early spring application of imazapyr may control seedlings for a single growing season.

Growth stage
Yellow starthistle should be no larger than the pre-bolt (rosette) stage for control with imazapyr. Smaller plants are controlled with lower doses than larger plants.

Type of site
Imazapyr is registered for non-crop sites, specifically industrial, right-of-way, fence row, storage yards, ditchbanks, drained ponds, marshes, and certain other noncrop sites.

Management objective
This herbicide provides non-selective control for one growing season where destruction of all vegetation is acceptable. It is normally not the herbicide of choice for yellow starthistle control, but will control that species as a secondary objective when used at high rates for other management objectives.

GLYPHOSATE
(Roundup; Rodeo)

Selectivity
Glyphosate is not selective.

Soil activity
Glyphosate activity does not occur through soil. When applied at normal use rates, it is fully effective only on small seedling or rosette yellow starthistle.

Type of site
This herbicide is registered for CRP, habitat management areas; industrial, recreational, and public areas; farmsteads and certain other terrestrial noncrop sites, prior to planting grasses and legumes in pastures, turf, and seed production sites.

Growth stage
Glyphosate must be applied before emergence of the planted crop.

Management objective
Application of this herbicide before planting aids in stand establishment. Glyphosate can be very useful when preparing to reseed a perennial grass in land infested with yellow starthistle and annual grasses. Virtually all yellow starthistle infestations have substantial populations of annual grasses such as downy brome, even though those plants may not appear to be prominent. In such cases, destruction of yellow starthistle is not enough to allow newly planted perennial grasses to succeed; the annual grasses must be destroyed too, or they will overpower and destroy the young perennial grass seedlings, and the seeding effort will fail.

At moderate doses, it can destroy not only emerged yellow starthistle seedlings, but many other weeds, *including annual grasses*, to provide several weeks of a competition-free seedbed for a new grass seeding. This is often enough to get newly planted

grasses well established and able to compete effectively against yellow starthistle. It must be used after the undesirable species have emerged but before the crop emerges. This can mean treatment either immediately before or immediately after the grass is planted. That practice can make the difference between success and failure.

All product label precautions must be followed when using a herbicide or planting susceptible plant species or crops on treated sites. Read it and understand it!

How should herbicides be applied for the best yellow starthistle control?

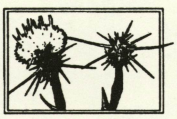
Ground equipment

Where the terrain permits, application by ground sprayers provides excellent coverage, and is the preferred method. Likelihood of off-target movement is low when boom sprayers with coarse sprays are used, and boom height is within 3 feet of the soil surface. If field shapes or topography are irregular, overlapping of spray patterns is unavoidable, so some overlapping of spray pattern will result in doubling herbicide dosages where equipment turns or compensates for topographic irregularities. Herbicide registration takes such unavoidable overlap into consideration. Herbicides that are used in accordance with labels do not cause illegal residues or unacceptable injury in rangeland, pasture, or cropland.

Aircraft application

Aerial application is the preferred method of herbicide application when terrain precludes use of ground equipment, and when urgency to meet timing requirements cannot be satisfied by ground application. It is the only satisfactory procedure for much of the canyonlands of the northwestern United States. Aerial application is generally less uniform than application by ground equipment on level ground, but more uniform than with boomless ground sprayers. The potential for off-target movement can be held within tolerable limits if carefully managed with due regard for atmospheric conditions and nearby sensitive sites. Herbicide labels must specify whether aerial application is permissible, and may dictate whether aerial application may be by fixed-wing or rotary-wing aircraft.

When applying herbicides from aircraft over rough terrain such as canyonlands, the maximum labeled and recommended dose should be used, considering the type of herbicide, vegetation, weed growth stage, environmental conditions, and other factors that may be listed on the herbicide label. It helps to compensate for low doses in spots due to nonuniform spread across the swath width and for terrain surface roughness that inhibits the deposition of herbicide beneath rock overhangs, shrubs, logs, and other vegetation. Swath widths must not be excessively wide, because correct overlap is necessary to ensure that adequate herbicide is applied over the entire treatment area.



What should I do to avoid getting herbicide resistant yellow starthistle?

Background

Only one occurrence of the development of genetic yellow starthistle resistance to a herbicide has been authoritatively recorded. It is associated with 8 consecutive years of treatment with a hormone-type herbicide. This appears to be a process of natural selection in an environment frequently treated with herbicide. Considering the long history of widespread, occasional application of hormone herbicides to yellow starthistle in the West, it appears that infrequent treatment with such herbicides has not generally resulted in noticeable resistance. It is not known, however, whether the same number of

treatments more infrequently applied may cause the same result. Thus, eight treatments at 5-year intervals over 40 years might result in the same degree of resistance at the end of 40 years as did those eight treatments at the end of 8 years. The conditions necessary to select for resistance in yellow starthistle are not known thoroughly enough to predict when resistance will occur, but the species has apparently proven its potential to develop resistance.

Herbicide-resistant yellow starthistle can spread by seed, and could result in establishment of new populations of the species, and of more resistant strains, where it has not occurred before. Herbicide-resistant yellow starthistle does not appear likely to invade by seed to dominate an established yellow starthistle population that is not suppressed by a hormone herbicide. Research with yellow starthistle indicates that resistant plants appear to be better adapted, or have the advantage over herbicide-sensitive plants, only when in a herbicide-treated environment. Theoretically, the genetic potential for resistance to hormone-type herbicides is inherent within all yellow starthistle populations. If so, high-frequency herbicide treatment will result in an increase in the proportion of resistant plants from within any population of yellow starthistle, without the necessity of introduction of resistant plants.

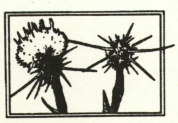
Recommendations to avoid genetic resistance

After treating with a hormone-type herbicide, ensure that yellow starthistle plants do not escape your treatment and produce seeds. Once you start treatment, be sure you destroy all of the treated yellow starthistle, and that none goes to seed thereafter. Inspect for surviving plants about 10 days after treatment. All affected plants will have distorted leaves, but surviving plants will show no symptoms or mild symptoms. Skips in the application pattern should be retreated, or the surviving yellow starthistle plants otherwise destroyed, before they begin to bolt.

Herbicide applications should be sufficient to kill all of the plants within the sprayed area. If they are not destroyed by the treatment, then they should be destroyed by some other means. If all plants are destroyed, then none will be selected for herbicide resistance during that particular year. Selection can occur later, however, if the management system depends on soil residual activity of the herbicide. In that case, herbicide-resistant seedlings that survive a year or more after the treatment should be destroyed. This means that avoidance of herbicide resistance should include a plan for consistently destroying yellow starthistle survivors by the most appropriate means. That plan should not be for a reapplication of the same herbicide, because this may simply hasten development of resistance to that herbicide.

Avoidance of herbicide resistance will depend on two management tasks: minimizing the frequency of use of herbicides with mode of action common to one another, and on ensuring that yellow starthistle does not survive the treatments. The first task is simply avoiding application of hormone herbicides too often (more than once every 5 years). No other alternatives are available for selective herbicide treatment of grassed areas. The second task involves inspection and either treating with an effective herbicide application or destroying the weed by hand.

If you have reason to suspect that your yellow starthistle has begun to develop resistance to the herbicides used, confer with your county Extension office on the advisability of arranging for a University of Idaho test for resistance.

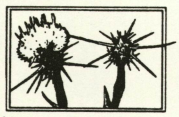


What will *not* prevent development of resistance?

There is currently no alternative herbicide effective enough to use as a substitute for hormone-type herbicides. Herbicide rotation using only presently registered hormone-type herbicides from year to year will only hasten selection for herbicide resistance. Herbicides with other modes of action, such as enzyme inhibitor herbicides, are not tolerated by forage grasses. Effective herbicide rotation to avoid development of genetic resistance is currently not possible because a diversity of herbicides is not available. Therefore you must base your choice of currently registered herbicides on efficacy and selectivity, not on avoiding development of tolerance. If herbicides with different modes of action

should later become registered for selective use on yellow starthistle, then herbicide rotation may be considered at that time to retard development of resistance.

This doesn't mean that herbicide rotation should not be used, because it may be an effective way to control a wider range of weed species. Dicamba and picloram are less effective on weeds of the mustard family, for example, so 2,4-D may be effectively used in combination or in alternate years with dicamba or picloram. This will not help prevent development of resistance, but it may help overall weed control.



THE BOTTOM LINE FOR ECONOMIC CONTROL WITH HERBICIDES

Prioritize areas to be treated. The most important sites to focus on are access roads, roadsides, other right-of-ways, livestock concentration areas, pasture gateways, livestock trailways, high-producing soils, and cropland. Concentrate on yellow starthistle control only on the property you can manage well. Determine whether you can omit controlling yellow starthistle on unmanageable property without violating state noxious weed laws or county noxious weed ordinances. If you cannot reasonably control yellow starthistle on some part of your property, consult the county weed control superintendent or ask the county commissioners whether they are willing to request that the Idaho Department of Agriculture designate a variance from state requirements to control yellow starthistle. The Idaho Noxious Weed Law provides for such a variance when it is in the best interests of the State. The variance is called a "special management zone."

In nonarable land, yellow starthistle control is better and lasts longer in proportion to the density and vigor of perennial grasses. For cropland protection from yellow starthistle, elimination of seed sources is important. In all crops, the crop density determines how effective the combination of herbicide and crop competition will work. Herbicides for yellow starthistle have relatively short lives; even picloram is herbicidally-effective for an average of only about 2 years. However, suppression of yellow starthistle allows rehabilitation of the competing vegetation so that it provides more vigorous competition against seedling weeds. The resultant weed suppression and improved grassland can benefit from the herbicide treatment for many years after the herbicide has dissipated.

Control of yellow starthistle will continue to be largely dependent on herbicides until research and development provides satisfactory suppression of this highly invasive weed. However, herbicide application for yellow starthistle control in noncrop land should only be used occasionally for temporary weed suppression, while longer-term curative practices centered around biological control are activated. Routine, frequent application of one kind of herbicide without other weed suppression mechanisms is not only costly, but may lead to eventual failure of the herbicide.

The bottom line is simply this: No single practice, herbicide use included, will keep yellow starthistle down. Herbicides provide the greatest return to investment when they are part of an integrated system.

FOR ADDITIONAL INFORMATION

See *Yellow Starthistle Biology and Management in Pasture and Rangeland*, University of Idaho Current Information Series No. 634; *Yellow Starthistle Management for Homeowners*, University of Idaho Current Information Series No. 1020; *Yellow Starthistle Management for Small Acreages*, University of Idaho Current Information Series No. 1025; and *Herbicide-Resistant Weeds and Their Management,* Pacific Northwest Extension Publication No. 437. For additional information on control of yellow starthistle and other weeds, contact your county University of Idaho Extension educator, or see the current issue of the *Pacific Northwest Weed Control Handbook.*

THE AUTHORS

Robert H. Callihan is Extension Weed Specialist and Professor of Agronomy. Lawrence W. Lass is a research support scientist. Both are in the University of Idaho College of Agriculture's Department of Plant, Soil and Entomological Sciences.

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, LeRoy D. Luft, Director of Cooperative Extension System, University of Idaho, Moscow, Idaho 83844. The University of Idaho provides equal opportunity in education and employment on the basis of race, color, religion, gender, national origin, age, disability, or status as a Vietnam-era veteran, as required by state and federal laws.

1,000 January 1996 ♻ Printed on recycled paper by Ag Communications Center $1