Yellow Starthistle Control in Nevada
An Integrated Approach to Invasive Weed Management

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Introduction
Native to the Mediterranean region of Europe and southern Eurasia, yellow starthistle (Centaraea solstitialis L.) probably arrived in the United States by way of contaminated alfalfa seed shipped to California. Yellow starthistle (YST) was first discovered in Sacramento in 1869 (DiTomaso et al., 1999a). This invasive weed now occupies approximately 22 million acres in California, and several million acres in the Pacific Northwest. It is a major threat to pastures, rangelands, and roadsides (Figure 1). Dense stands of this weed drastically reduce forage production by quickly displacing native plants and shrubs and forming a monoculture. This in turn affects wildlife populations, grazing capacity, recreation and many other economic aspects of a community.

The key to keeping this invasive weed out of Nevada is prevention. Prevention requires teaching property owners, managers, land users, and the general public how to identify YST and eradicate early infestations. The least costly alternative for land managers and communities is to prevent the establishment of an infestation. When prevention does not work, or is not implemented in time, several expensive control methods may be necessary. Biological, physical and chemical controls, when used in combination, have the greatest chance of eradicating or controlling yellow starthistle. It must not go unmanaged; it has already invaded 11 of Nevada’s 17 counties (Figure 3). Fortunately, infestations are small and may be eradicated in most cases.

The total cost of an invasive weed is more than the mere cost of eradicating the infestation. Ecosystems are damaged by the weed and those damages cause economic losses to recreation, agriculture, conservation and preservation. If not controlled, YST will overwhelm Nevada landscapes as cheatgrass (Bromus tectorum L.) and perennial pepperweed (Lepidium latifolium L.) have done.

Biology
Yellow starthistle is a winter annual and in most of Nevada, it germinates in early spring. In mild climates, it germinates in fall and overwinters as a rosette (a prostrate plant with leaves, but no stems). YST is dependent on seed production for its spread and continued survival. The plant is a prolific seed producer that can reach heights of five feet or more in moist areas with good soils. In Nevada, it grows from six inches to three feet tall. Average seed production ranges from 20 to 120 seeds per seedhead. A single plant has the potential to produce up to 150,000 seeds, depending on the plant’s size and flower density, both of which increase with favorable spring precipitation and good soil nutrition. Infestations can produce 50 to 100 million seeds per acre (Callihan et al., 1992; DiTomaso et al., 1999b; and Maddox, 1981). Ninety-five percent of the seeds produced are viable and most germinate the following year whenever soil moisture is available and temperatures are favorable. Seeds that do not germinate

1All authors supported in part by Nevada Agricultural Experiment Station
in the first year can remain viable in the soil for ten years (Lanini et al., 1995). Seeds germinate extremely well when given adequate light and moisture and when temperatures range from 50 °F to 70 °F.

After germination, YST dedicates most of its energy to root growth. Its roots extend three feet or more into the ground in a short time. This explains why it competes so well against shallow-rooted native plants during the hot, dry, summer months. It acquires water from deep in the soil while shallow-rooted plants cannot. Flowering begins in late May or June, continually producing bright yellow flowers with one-inch thorns until the first frost (Figure 2). Deep, extensive roots support YST regrowth after it is mowed or grazed in early summer.

YST is usually found below 7,000 feet elevation in dry, sunny areas with annual precipitation between 10 and 60 inches. Recently, it was found at an altitude of 8,000 feet in the Sierra Nevada mountain range (Steve Schoenig, personal communication).

General Considerations

Eradication is very difficult and usually unrealistic once an infestation has become established. However, a well-designed control program can result in large reductions over several years if all seed production is stopped (Thomsen et al., 1996). It is extremely important to realize that seed production must be stopped in order to control this weed. For complete control, a manager must know its invasive characteristics and the desirable species that can be grown to compete with it for resources. To successfully manage YST, make **mapping, monitoring, using caution** and being persistent a part of the guidelines used for control.

**Mapping** allows managers to see the big picture as well as many details. Logical relationships become more readily apparent, including sources of the infestation, direction, rate of spread and property boundaries (Johnson et al., 1999). Maps should include weed identification, areas of infested land and density of an infestation. A map can answer several important questions: What are the sources of the weeds? How are the weeds transported into and around an area? Along which corridors? Where will the weeds most likely spread? Who owns the infested property?

Once control has begun, maps should be used over several years to make comparisons among control measures and assess which are most effective. Maps of infestations may be used to garner support from influential people, the general public and civil authorities. Maps can show what the invasive weed is doing to the area, how effectively resources are used to combat it, and in the worst case, the eventual outcome if nothing is done. For example, Figure 3 shows the counties infested with yellow starthistle. Eradication should begin in those counties. In the uninfested counties, quarantine laws should be established and people instructed how to recognize, then eradicate YST when it first appears.

**Monitoring** and assessing the success rate of a control program is less difficult if mapping has been done and the above questions answered. Monitoring is essential in the war against invasive weeds. Land managers who do not monitor and evaluate the effectiveness of their control program will often repeat costly mistakes, waste valuable resources and time. Types of actions to monitor include: what was done—where, when and how, success rates, failures, and associated costs. Another monitoring and evaluation question is: What were the short-term and long-term treatment results of the project?

It is important to use **caution** when working in infested areas, not only to prevent further infestations, but also to eliminate bodily harm from equipment, avoid
chemical misuse and environmental damage. Remain persistent throughout the entire weed control program. This requires patience through several years until the last seed germinates.

**Prevention**

With the advent of herbicides, prevention of weed infestations is often neglected. Prevention, in combination with other integrated weed control strategies, plays an important role in eliminating the movement and establishment of invasive weeds. Prevent invasive weeds from spreading by:

1. initiating quarantine laws,
2. preventing flowering and stopping dispersal of seeds and plant parts,
3. containing neighboring infestations,
4. minimizing soil disturbances,
5. routinely detecting and eradicating early infestations,
6. establishing competitive plant species and properly managing areas not infested.

The best and most economical way to manage weeds is to stop them from advancing into new areas. Unfortunately, many land managers, recreationists and the general public are unfamiliar with invasive weeds or what an infestation looks like until it is large and noticeable, which is often too late. Land managers can prevent the introduction of invaders in these ways:

1. Checking and cleaning the undercarriage of vehicles before leaving an infested site or entering uninfested property.
2. Checking soil for seed or plant parts before introducing it into a new area.
3. Feeding only weed-free forage.
4. Grazing animals before weeds set seed and feeding livestock grazed on infested range weed-free forage before moving them to uninfested land.

By observing good land management practices, managers can prevent the introduction of invasive species. Sensible practices also include using rotational grazing, irrigating with water free of invasive weed seeds or propagules, conserving water for use on desirables species over the whole season, controlling erosion, and establishing competitive vegetation in open land.

**Early Detection**

Detection and control of individual plants or small groups of plants after germination is most important in preventing invasive plant establishment. Biennial or perennial plants can be successfully treated following germination either mechanically or chemically as if they were annuals. All weeds are easiest to control before they grow deep roots and begin reproducing. Eradication of annual YST before it produces seed is critical. Invasive weeds that are ignored and allowed to produce seeds and other propagules create the need for a more expensive, long-term weed control program. This requires years of treatment until all the invasive weed seeds or plant parts in the soil have germinated or grown and have been killed.

**Biological Control**

The fundamental invasive weed problem occurs when weeds are introduced into a new area without their natural enemies or where competition from other plants is minimal. Without their biological controls present, invasive plants have a competitive advantage as they encroach upon a healthy, diverse, properly functioning ecosystem. Slowly but surely they successfully occupy space in the area. If, however, they are weakened by attack from natural predators, they may not successfully invade a healthy plant community. Biological controls of YST include the use of grazing animals, plant diseases, insects, and competition from other plant species. Natural enemies of an invasive weed must only attack the invaders and not commercial crops or plants. In Italy and Greece there are 42 herbivorous insect species that attack yellow starthistle and keep it under control (Clement, 1990). Biological control is most effective in combination with other treatment methods as it will not eradicate an invasive species, only weaken it.

Several insect species that attack YST flowers or seed heads have been introduced into many western states, including Nevada. Not all have become successfully established. For example, in California, established species include the false peacock fly (*Chaetorellia succinea*, Figure 4), peacock fly (*Chaetorellia australis*), gall fly (*Urophora sirunaseva*), seed-head weevil (*Bangasternus orientalis*), hairy weevil (*Eustenopus villosus*) and flower weevil (*Larinus curtus*). The most

**Figure 4.** The false peacock fly lays its eggs in the yellow starthistle seedhead. The eggs hatch and produce larvae that feed on the seeds.
promising of these are the false peacock fly and the hairy weevil (Lincoln Smith, personal communication). The false peacock fly, which was accidentally introduced into California, has become established in areas where the true peacock fly has not. Currently, the false peacock fly is being tested for its selectiveness to determine if it will damage native and commercial crops. Before an insect is approved for introduction, it must be shown to be host specific and that it will not attack desirable plants. Insect predators are hard to establish and it may take years before they become widely dispersed and provide effective control.

The success of biological controls is directly related to the amount of site disturbance. Control methods such as grazing, mowing, tilling or burning cannot be used for several years in conjunction with insect control and if the infestation can be eliminated by other means, then it does not make sense to release bioagents (Thomsen et al., 1996). Use of herbicides and hand pulling are control methods that will not harm insect populations. Biological controls should be part of a long-term, integrated management plan on established infestations.

Some livestock grazing has been successful in controlling YST, however, timing, duration and intensity are critical. Grazing reduces weed biomass and seed production. Cattle, sheep and goats will eat the weed before the spines have appeared and after it has bolted. Cattle and sheep will not graze yellow starthistle after the spines appear. Goats eat the spiny flowers and will graze it all season. Consequently, goats are best for controlling relatively small infestations. Crude protein levels for this weed range from 11 to 28 percent at the bud and rosette stage, respectively. These levels meet the protein requirements of most ruminant livestock. Grazing is usually most effective during May and June, dependent upon location and weather conditions.

Horses should be kept away from YST infestations. Grazing YST causes horses to develop *Equine-nigropallidal encephalomalacia* or “chewing disease”.

This neurological disease causes horses to stop eating but continue to chew and eventually die. Horses may develop chewing disease within weeks after grazing infested forage, although some may graze infested forage for years before getting the disease (Joslyn, 2001). The length of time before a horse develops the disease may be related to the density and the size of the infestation.

**Chemical Control**

Herbicides are valuable in managing invasive weeds. Dense stands of YST can be significantly decreased if chemicals are applied at the proper rate and time. They are an excellent tool as part of an integrated weed management program.

Pre-emergent, post-emergent, selective and non-selective products are recommended for YST management. Selective herbicides kill only one type of plant, such as broadleaf species or grasses. Non-selective herbicides kill all types of plants. Pre-emergent herbicides are applied before seeds germinate, while post-emergent products kill established plants (Lanini et al., 1995). To be effective, pre-emergent herbicides must remain in the soil throughout the season because YST seeds germinate whenever moisture and temperature conditions are favorable. Post-emergent herbicides work best on seedlings (Table 1). Adequate control with a single application rarely occurs and follow-up spot treatments are usually necessary. Delaying control will allow more weeds to be treated; however, the plants will be larger and require more herbicide. Table 2 lists herbicides recommended for YST control with their corresponding registered use, application rate and success rate. Care must be taken because some herbicides may persist in the soil and interfere with revegetation in subsequent years. Native plants and crops may also be damaged or killed. Application of fertilizer with a selective herbicide may stimulate greater competition by native plants and grasses.

**Physical Control**

Mowing, tilling, hand-pulling and controlled burning are physical control methods used to reduce YST infestations. Mowing is effective if it occurs when two to five percent of the seed heads are flowering. This prevents the production of viable seed and also ensures that the lowest branches of the weed are above mower height. If mowed too early, the architecture of the plant changes from upright to horizontal and more seeds will be produced per unit area. In field studies, control was directly related to height of cutting, i.e., the closer to the ground, the better the control. In Nevada, mowing at such a low height is usually impossible without equipment damage, particularly on rough or uneven ground. A flail mower may be a possible exception. Mowing is
Tilling or diskng the infested area early in the summer can lead to rapid reinfestation by invasive weeds unless it is repeated and accompanied by seeding with desirable species to create competition. Hand-pulling small infestations works well because it prevents seed production and slows weed re-establishment. This may be the best option in most urban locations. YST’s response to mowing, tilling and hand-pulling varies according to site conditions and climatic factors. Therefore, continual monitoring over several years followed by retreatment as needed is important to achieve beneficial results over the long-term.

Controlled burning is best conducted after native species have dispersed their seeds, but before YST has produced seeds. Burning promotes legume growth and can be used in the second year of a control program after chemical treatment in the first year. This option stimulates grasses in the first year and legumes in the second year while controlling YST. Burning cannot be used with biological controls, in areas with high fire danger, or near cities with air quality restrictions. For these reasons, burning is the most limited physical control method, but it remains a viable option in some situations.

**Plant Competition**

One of the most sustainable methods for control of YST infestations is competitive plant revegetation (DiTomaso et al., 2000). Plant competition allows land managers to maintain high forage production and plant diversity. Before beginning, consider the soil conditions, elevation and climate at the site. Land-use objectives also must be considered, including forage production, wildlife habitat development, recreation or conservation (Johnson et al., 1999). Success requires choosing a plant that is more competitive than YST. Only a few plants have proven aggressive enough to displace invasive weeds. Perennial bunchgrasses are the most commonly used species, but many broadleaf legumes can also be used. Chemical control can help these competitive species gain a foothold in a YST infestation. Herbicide selectiveness must be matched with the competitive species. For example, a broadleaf herbicide cannot be used during revegetation with a legume, but is recommended when establishing competitive grasses. Contact your local extension educator for help with selecting plant/herbicide combinations. Because of the ecological diversity within Nevada, no single species or combination of species will be effective in every situation. Long-term success using plant competition depends on monitoring, spot treatment and reseeding in subsequent years.

**Integrated Control Methods**

Each control method will differ in effectiveness in different years during a long-term invasive weed control program. The key is to optimize the success of any control method by using it when it is most effective. Herbicides are most effective if used in the first year of a long-term control program. They are also important in follow-up spot treatments. Grazing, revegetation and release of biological controls can be used in most multi-year, integrated programs, but not in the same year. For example, revegetation can only be used with controlled burning if the seeding follows the burn. Using biological controls excludes burning because it kills the control agent. Controlled burning and mechanical methods are most effectively used in the second and third years of a multi-year effort. Again, managers of multi-year programs must determine the control methods to be used based on what was used in previous years or what will be used in the future.

**Additional Information and Funding Resources**

Integrated, multi-year weed programs require extensive planning and timely, precise execution. For help, contact Dr. Wayne Johnson at the University of Nevada, Reno, or your local extension educator. Additional contact information is provided on the back page of this publication. The University of California, Davis and Montana State University both provide information on invasive weed control on the Internet and in their respective publications. The federal government has established a national panel of invasive weed researchers to make recommendations on prevention, public awareness, monitoring and reporting, mitigation and control legislation, and regulation of invasive plant species. In Nevada, weed control should be a joint effort among federal, state, county and local weed control officials, and private citizens. It is best to form an invasive weed management area among these groups and others, particularly private landowners, to develop long-term management plans.

**Economic Impacts of Yellow Starthistle**

Examples of natural resource damage resulting from YST infestations are well documented in weed science literature. However, the economic impacts of invasive weeds must also be considered as an incentive to control them. Economic impacts include all direct costs of treatment, i.e., equipment use, herbicides, labor, fuel, etc. Economic impacts also include the foregone benefits of damaged natural resources. Foregone benefits are defined as the monetary or nonmonetary losses that occur due to an invasive weed infestation. Whether YST reduces the quality of recreational activities in a park or perennial pepperweed (*Lepidium latifolium* L) reduces soil productivity, foregone benefits of the land they damage must be considered. We must also realize that everyone is
affected by an invasive weed infestation. Figure 3 illustrates three important points. It shows that YST can survive in many Nevada counties and it displays which counties need to control the weed and which need to prevent it from entering. In California, YST infestations are so enormous that there is no chance for elimination. Containment is the only possibility.

Economic damages are separated into direct, indirect and induced effects. Direct effects include the cost of treating an invasive weed. Herbicide, labor, equipment and revegetation expenses are all direct effects. Indirect effects are foregone benefits caused by an invasive weed infestation. These losses can occur as reduced grazing, harvest, recreational or ecological benefits. Together, direct and indirect effects create an induced effect on the local economy. For instance, a reduction of recreational activity in one area can reduce tourism revenue for that area and for the state or region. Induced effects can reduce government revenue as well, because tax revenue may decrease.

There is a lack of literature pertaining to the economic impacts of YST infestations in California. However, the University of Nevada, Reno is currently studying the economic impacts of perennial pepperweed on grazing and hay production in Nevada. Preliminary results show that perennial pepperweed infestations cost land managers a considerable amount of revenue in lost grazing and hay harvest receipts. The invasive characteristics of these two weeds are slightly different; however, the natural resources they damage are similar. Knowing this, we can assume that the economic and ecological effects of yellow starthistle would be similar to those of perennial pepperweed.

Perhaps the most devastating attribute of YST is that it can grow alongside cheatgrass. This may eliminate grazing on infested lands because YST will make cheatgrass more difficult to graze. In Nevada, a reduction in grazing areas will severely hurt the cattle industry and government land management agencies will lose revenue. Other sectors that are affected by YST include dairy, hay, and recreation.

The direct economic impacts of controlling an invasive weed like YST are shown in Figure 6, which demonstrates the drastic increase in costs if the land manager chooses to delay a control program over several years. These estimates are based on a constant expansion rate of YST and are estimated using only chemical control costs. Keep in mind these costs only include direct effects. Benefits from grazing or recreational tourism also decrease as the infestation expands its territory. Land managers must weigh the treatment cost of an infestation with the foregone benefits of infested land.

**Future Implications**

Yellow starthistle will continue to invade prime agricultural and recreational land within Nevada if it is not contained and controlled. The threat of damaged recreation land and inefficient agricultural land paints a bleak outlook for Nevada’s future land production capabilities. Figure 7 shows the battle line between California and Nevada. YST is moving over the Sierra Nevada mountain range and has already made its way into several Nevada counties. However, it is not too late to prevent this unwelcome visitor. It can be avoided or eradicated in many areas and contained in others if we act immediately to manage current and emerging infestations. Figure 7 only shows reported YST infestations on or near the state border, but does not show infestations in several Nevada counties that have been reported to the University of Nevada, Reno Herbarium (Figure 3). The lesson Nevada can learn from California is that we must work hard and not allow YST to occupy a large amount of land. Control must be a cooperative effort among agricultural land managers, government agencies, recreation and conservation land users and the general public. YST can invade an area quickly and create a dense stand in only two to three years. This is why it is critical to keep it out through prevention and early eradication. This publication is designed to help land managers and others control and eradicate yellow starthistle. Not every treatment scenario could be included, therefore the following pages contain additional contact information.

**Figure 6.** Annual chemical control costs if yellow starthistle control is delayed (graphic courtesy Eiswerth et al., 2001).
Figure 7. Nevada-California border, red dots illustrate the presence of yellow starthistle. (Graphic courtesy CA Dept. of Food and Agr., 2000).

Literature Cited
Schoenig, S. Personal communication. 2001. California Department of Food and Agriculture.
Smith, L. Personal communication. 2001. USDA Agricultural Research Service.

Internet Invasive Weed Resources

Australian National Weeds Strategy

California Native Plant Society
http://www.cnps.org/index.htm

California Weed Science Society
http://www.cwss.org/

Colorado State University
http://www.arapcsuext.org/agri/noxious2.htm

Database of IPM Resources (DIR)
http://www.ippc.orst.edu/cicp/gateway/weed.htm

University of Montana Invaders Database System
http://invader.dbs.umt.edu/

USDA-NRCS, Federal and State Noxious Weeds List
http://plants.usda.gov/plants/cgi_bin/topics.cgi?earl=noxious.cgi

Western Society of Weed Science
http://www.wsweedscience.org/

Cover photo courtesy University of California, Davis, Division of Agriculture and Natural Resources.
Government Agency Contact List

(07/01/01)

United States Department of the Interior Bureau of Land Management (BLM)

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Palomino Valley Corral
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Figure 8. Treatment recommendations for yellow starthistle control when it germinates in the fall and overwinters as a rosette.

Figure 9. Treatment recommendations for yellow starthistle control when it germinates in late winter and spring.
### Table 1. Percent control of yellow starthistle when the herbicide is applied at the seedling stage.

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Rate per acre</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>Percent YST Killed</th>
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<tr>
<td>Clopyralid</td>
<td>0.25 oz.</td>
<td>55</td>
<td>45</td>
<td>68</td>
<td>63</td>
<td>64</td>
<td>55</td>
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<tr>
<td></td>
<td>0.5 oz.</td>
<td>86</td>
<td>85</td>
<td>75</td>
<td>87</td>
<td>84</td>
<td>85</td>
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<tr>
<td></td>
<td>1.0 oz.</td>
<td>91</td>
<td>93</td>
<td>98</td>
<td>100</td>
<td>97</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.0 oz.</td>
<td>83</td>
<td>98</td>
<td>98</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.0 oz.</td>
<td>93</td>
<td>100</td>
<td>98</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.0 oz.</td>
<td>97</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>98</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Chlorsulfuron + 2,4-D</td>
<td>18 oz.</td>
<td>95</td>
<td>69</td>
<td>90</td>
<td>90</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Chlorsulfuron + 14 oz.</td>
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<td>95</td>
<td>91</td>
<td></td>
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<td></td>
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<tr>
<td>Triclopyr</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2,4-D</td>
<td>16 oz.</td>
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<td></td>
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<td>90</td>
<td></td>
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<tr>
<td>Triclopyr</td>
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<td>58</td>
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</table>

Courtesy DiTomaso et al., 1999

### Table 2. List of herbicides registered in Nevada that may be used to control yellow starthistle.

<table>
<thead>
<tr>
<th>Herbicide Names</th>
<th>Registered Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common</td>
<td>Trade</td>
</tr>
<tr>
<td>Atrazine</td>
<td>Aetrex</td>
</tr>
<tr>
<td>Bromacil</td>
<td>Hyvar</td>
</tr>
<tr>
<td>Chlorsulfuron</td>
<td>Telar</td>
</tr>
<tr>
<td>Diuron</td>
<td>Karmex</td>
</tr>
<tr>
<td>Hexazinone</td>
<td>Velpar</td>
</tr>
<tr>
<td>Isoxaben</td>
<td>Gallery</td>
</tr>
<tr>
<td>Oxyfluorfen</td>
<td>Goal</td>
</tr>
<tr>
<td>Simazine</td>
<td>Princep</td>
</tr>
<tr>
<td>Sulfometuron</td>
<td>Oust</td>
</tr>
<tr>
<td>Tebuthiuron</td>
<td>Spike</td>
</tr>
<tr>
<td>2,4-D</td>
<td>Several</td>
</tr>
<tr>
<td>Clopyralid</td>
<td>Transline</td>
</tr>
<tr>
<td>Dicamba</td>
<td>Several</td>
</tr>
<tr>
<td>Chlorsulfuron</td>
<td>Telar</td>
</tr>
<tr>
<td>Glyphosate</td>
<td>Roundup</td>
</tr>
<tr>
<td>Metsulfuron</td>
<td>Escort</td>
</tr>
<tr>
<td>Picloram</td>
<td>Tordon 22K</td>
</tr>
<tr>
<td>Triclopyr</td>
<td>Garlon, Remedy</td>
</tr>
<tr>
<td>2,4-D + Clopyralid</td>
<td>Curtail</td>
</tr>
<tr>
<td>Tordon 22K + 2,4-D</td>
<td></td>
</tr>
<tr>
<td>Triclopyr + Clopyralid</td>
<td>Redeem R&amp;P</td>
</tr>
</tbody>
</table>

**Precaution:** All pesticides have both benefits and risks. Maximize the benefits and minimize the risks by following the label. Labeled information contains both instructions and limitation. Pay close attention to the directions for use and the precautionary statements. Pesticide labels are legal documents and it is a violation of both federal and state laws to use a pesticide in a manner inconsistent with its labeling. The pesticide applicator is legally responsible for the proper use of a pesticide. Always read and follow the label! The use or nonuse of chemical names does not constitute an endorsement or criticism of a product containing the chemical.
Roadsides/Fields

**Late May to mid-June:** Mow YST at early flowering stage.  2 - 5% flowering.

**June to July:** Mow the regrowth 4 to 6 weeks after first mowing.

**July:** Use a post-emergent herbicide to spot-spray surviving plants 1 to 2 weeks after second mowing. Burns are more effective if mowed YST is allowed to dry and other vegetation growing with YST (e.g., cheatgrass) is dry enough to catch fire.

**After 2 or 3 years:** Establish desirable plant species to compete with YST and meet other land-management objectives. This can be done sooner if adequate measures are taken, such as spot treatments, to reduce the entire weed population.

Small Parcels

**September to October:** Irrigate parcels to stimulate seed germination and seedling growth.

**October to November:** Cultivate or use herbicides to kill seedlings. Repeat treatment after rainfall to eliminate new seedlings, if and where they grow.

**Late May to mid-June:** Mow YST during the early flowering stage.

**June to July:** Mow the regrowth 4 to 6 weeks after first mowing.

**July to August:** Remove surviving plants before seeds mature by hand-pulling, hoeing, flaming or treatment with post-emergent herbicides.

**After 2 or 3 years:** Establish desirable plant species. Spot-remove any remaining YST.

Dryland Pasture

**Unimproved**

**Mid- to late May, June to July:** Graze bolting plants (ruminants only). If possible, remove animals and bring back after 2 weeks to graze regrowth. Repeat regrowth grazing if necessary. If pasture rotations are not used, maintain grazing pressure for 1 to 2 months.

**July:** To reduce the chance of overgrazing of desirable species, discontinue after the first or second grazing and mow the regrowth in early flowering stage.

**Improved**

**Late September to October:** Establish forage plants such as subterranean clover or a grass/legume mix.

**November to May:** Manage seeded pastures with planned grazing to ensure a good stand (Murphy et al., 1973).

**Mid-May:** Graze bolting YST.

**Late June to July:** Mow regrowth to eliminate seed production.

Hay Fields

**April to June:** Cut and bale forage crops.

**June:** Allow YST to reach bolting stage and graze with cattle or sheep. Repeat grazing on regrowth after two weeks.

**June to July:** An alternative is to mow YST instead of grazing it. Bale and feed to ruminant animals if economical. **Do not feed YST contaminated hay to horses.**

Encourage competitive forage production with fertilization and irrigation. Use a preemergent herbicide where practical on established hay. Use a selective herbicide or other spot treatment in grass hay production, if economical or tilling and hand-pulling.

Rangelands

**Year 1:** Develop long-term management and containment plan with landowners, resource conservation districts, agricultural commissioners, agency personnel, recreational users and other interested parties.

**Ongoing:** Contain large infestation by eradicating pioneer plants or small infestations. Use backpack sprayers on foot, horseback, or ATV. Manage grazing periods to enhance competition from resident vegetation. Restore areas such as riparian corridors and valley bottomlands that formerly supported trees and shrubs with appropriate native species.

**May to June:** Release biocontrol insects on large infestations that will not be disturbed by grazing, mowing, or fire. This method has shown some success, but has not been proven to reduce YST populations in the field in many sites.

**Mid-May to July:** Manage dense stands by grazing during the bolting stage. Graze the regrowth or supplement with timed mowings where terrain is rugged and suitable to further reduce seed output. Employ goats where possible once the spines are formed. Use prescribed burns where appropriate.
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