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Ecology and Management of Oxeye Daisy (*Leucanthemum vulgare* Lam.)

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Figure 1. An oxeye daisy infestation.

Abstract

Oxeye daisy is a European perennial forb that spreads by seed and creeping rhizomes. Its distinctive flowerhead with yellow disc and white ray flowers and its spatula-shaped, lobed rosette leaves help identify this Montana Category I noxious weed. First recorded from Lewis and Clark County in 1890, it spread to 24 counties by 2007. Oxeye daisy is a prolific seed producer and seeds can survive in the soil for up to 39 years. The creeping rhizomes enable oxeye daisy to form dense populations avoided by livestock and that crowd-out native and forage plant species (see Figure 1).

Herbicides that temporarily reduce oxeye daisy populations include 2,4-D, aminopyralid, metsulfuron, and picloram. Applications in the rosette or pre-bloom stages of growth are most effective. Nitrogen fertilization may also reduce populations within competitive plant communities with low soil fertility. The shallow root system of oxeye daisy makes it susceptible to control with tillage, however, cleaning tillage equipment after use is important to prevent spread and follow-up weed management may be needed to control plants re-generating from rhizomes and seeds. Persistent hand pulling and grubbing that removes the rhizome may be

practical on small-scale populations. Mowing before bloom will reduce seed production but will not reduce populations. Prescribed burning should be combined with other control practices. There are no biological control insects available for oxeye daisy management. Applying practices that encourage competitive desired plants will improve control procedures and reduce the spread of oxeye daisy. Follow-up monitoring after control is important to target populations growing from the long-lived seed bank.

PLANT BIOLOGY

Taxonomy

Oxeye daisy is in the sunflower taxonomic family (Asteraceae). The scientific name, *Leucanthemum vulgare*, literally translates to common white flower; the generic name is made up of the Greek roots *leuk* meaning white and *anthem* meaning flower, and the species name, *vulgare*, is from the Latin *vulga* meaning common. Synonyms include *Chrysanthemum leucanthemum* and *Leucanthemum leucanthemum*. Oxeye daisy has many common names including bull daisy, button daisy, dog daisy, field daisy, goldens, marguerite, midsummer daisy, moon flower, and whiteweed.

In the United States, there are four species other than oxeye daisy in the *Leucanthemum* genus, all introduced; *L. serotina* (giant daisy) is found in the Great Lakes States and New England, *L. lacustre* (Portuguese daisy) is found in Wyoming and the Southeastern U.S., and *L. maximum* (max chrysanthemum, also English field daisy) is found in the west coast states, Colorado, Louisiana, Ohio, and New York. Shasta daisy (*Leucanthemum x superbum*) is a hybrid cross developed (1901) from oxeye daisy flowers dusted with pollen from *L. maximum*, then selected progeny dusted with *L. lacustre*, and finally selected progeny of this cross dusted with pollen from *Nipponanthemum nipponicum* (Japanese field daisy). Oxeye daisy is closely related taxonomically to common tansy (*Tanacetum vulgare*).

Figure 2. oxeye daisy rosettes in mid-May.

Identification

Rhizomes are shallow and obliquely branched. Rosettes grow from prostrate basal stems with adventitious buds capable of growing roots. Rosette leaves have long stalks with pinnatifid, subpinnatifid, or coarsely and irregularly-toothed margins (see Figure 2). Because of the long petiole and blade shape, rosette leaves have been described as spatula-shaped. Rosettes will grow in clumps resulting in plants with multiple flowering stems that are glabrous to slightly pubescent, 12 to 30 inches (30 to 76 cm) tall, and are simple or moderately branched (see Figure 3). Stem leaves are sessile (without a petiol) and spirally arranged on the stem. Their shape is lanceolate or ligulate and their margins are coarsely-toothed (see Figure 4). All leaves are hairless, dark green, and glossy. Flowerheads are solitary at the stem tips and 1 to a little more than 2 inches (2.5 to 5.5 cm) in diameter (see Figure 5). Fertile disc flowers are many (hundreds), tiny, and bright yellow, and there are 20 to 30 white, petal-like, sterile, ray flowers. The achenes (one-seeded fruits) are black with eight to 10 longitudinal ribs, 1 to 1.5 mm long, narrowly obovate, with small firm, rounded nodules or swellings at the apex, and without a pappus. When crushed, the plant has an unpleasant odor. Oxeye daisy can be distinguished from Shasta daisy by its smaller stature and lobed rosette leaves (Shasta daisy rosette leaves are dentate).

Figure 3. An oxeye daisy plant in the bud stage of floral development.

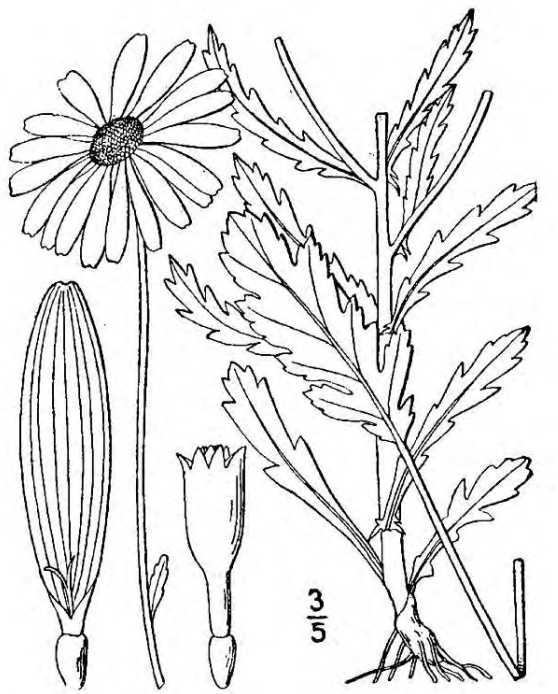

Figure 4. Oxeye daisy leaf, flowering stem, and seed depiction.

Life History

Oxeye daisy is a perennial forb that reproduces by seeds and rhizomes. Seed production potential is tremendous. One study in England found 250 seeds per flowerhead. A vigorous plant is reported to produce about 26,000 seeds, and smaller plants produce 1,300 to 4,000 seeds per plant. An infested pasture was calculated to produce 10,710 seeds/m^2. In one pasture, the seed bank in the top 18 cm of soil was estimated at 6.6 million/ha. A seed burial study measured seed viability after six years at 82%, and 1% were viable after 39 years. Thus, the above-mentioned pasture could have 66,000 viable seeds/ha (27,710 seeds/acre) in the soil after 39 years of continuous oxeye daisy control.

Seeds set mostly in August. Achenes ripen rapidly and seeds are viable ten days after flowers open. There are no mechanisms of seed dormancy and germination can occur throughout the year when conditions are favorable. Establishment from seed is most common in the spring. Seedlings have a relatively high rate of survival and demonstrate tolerance to drought. Rhizomes develop when seedlings are at the sixth-leaf stage. Stems emerge from rhizome buds in April and May. A single plant can form many rosettes, each rosette producing one flowering stem. Plants flower in June, July, and August as long as soil moisture is available for active growth. Plants die back to the ground under drought conditions but rosettes can grow from rhizomes when fall moisture and temperature conditions are favorable. Over-wintering buds are on rhizomes at or near the soil surface. The longevity of individual plants or rhizomes has not been determined.

Figure 5. Oxeye daisy flowers blooming in July.

Habitat

In Montana, oxeye daisy is commonly found in pastures and hay meadows, along roads, railroads, streams and lakes, in gardens and lawns, in open and thick woodlands, and along irrigation ditches. It usually grows on mesic sites. It grows on a wide range of soil textures, has moderate requirement for nitrogen, and is more abundant on poorer soils. It is found more often on basic or neutral soils and less often on acidic soils. It has a low tolerance for shade and prefers open sites. History indicates oxeye daisy is well adapted to disturbances associated with humans. It is in Far Eastern legends, achenes have been documented from the Iron Age (eight century BC), from the Roman period (first century BC), and from post-glacial Britain.

Spread

Oxeye daisy is native to Europe north to Scandinavia and Lapland, the British Isles, Russia and central Asia. It was imported to North America as an ornamental, and it has been included in popular "wildflower" seed mixes. Along with being an escaped ornamental, oxeye daisy was brought to North America as a contaminant of imported hay and grain seeds.

Oxeye daisy achenes have no specialized morphological features facilitating dispersal. A dispersal study in England found few seeds traveled farther than three feet from the parent plants. Sheep grazing and cutting hay treatments had little effect on seed dispersal distance in that study, but more seeds were dispersed in the grazed treatment than the hay-cut treatment, probably because cutting removed unripe seed and seed heads. The study suggests oxeye daisy populations may be more dispersal limited than site limited.

Long distant spread of oxeye daisy is dependent on factors other than morphological features of the achene. Probable vectors of spread include people, vehicles, and animals. Livestock and

wild ungulates likely transport seeds embedded in their fur and in soil on their hooves. Seed-eating birds also are likely vectors. People hiking, riding horseback, or driving all-terrain vehicles may transport seeds long distances. Movement of soil containing seeds on equipment, vehicles, and shoes is a probable means of long-distant transport. Oxeye daisy seeds can spread from infested hay meadows when plants with flowers are baled in hay.

Impacts

Oxeye daisy is predominantly a weed of pastures and hayland where it crowds-out preferred forage species reducing carrying capacity for livestock and the value of hay. Where it spreads onto rangeland it will reduce livestock forage and plant community diversity. Allelopathic compounds have not been found in oxeye daisy. However, one study found a high number of root-feeding nematodes associated with the roots of oxeye daisy. There is evidence that the soil microbial community of a plant can suppress the growth of neighboring species, and association with nematodes may suppress other species growing with oxeye daisy. Oxeye daisy was used in Europe as a salad green.

MANAGEMENT

Herbicidal Control [1/]

On pastures and rangeland, oxeye daisy can be temporarily suppressed by aminopyralid, metsulfuron, picloram, or 2,4-D. The recommendation for picloram is one pint product (Tordon 22K® or Picloram22®) per acre to actively growing plants before bloom or to fall re-growth. This rate applied to rosettes in mid-May provided two years control on a forest meadow site. On that site three years after treatment, an average of 23 rosettes/m^2 was measured. The recommended rate for metsulfuron is one ounce per acre product (Escort® or Cimarron®) applied to rosette plants in the spring (May). This treatment also provided two years of control on the forest meadow site with an average of nine rosettes/m^2 three years after treatment. The metsulfuron treatment was not statistically different than the picloram treatment. A non-ionic surfactant is needed in the spray solution at 0.5% by volume for metsulfuron to be effective. The label rate for aminopyralid is 4 to 6 ounces product (Milestone®) per acre to plants in the pre-bud stages. Pre-bloom foliar applications of 2,4-D at 2 quarts per acre with repeated applications to re-growth can also be used. Glyphosate applied at one to two quarts per acre will kill oxeye daisy on cropland or where re-vegetation is planned. Label information for all herbicides should be carefully followed not only for application restrictions but also for restrictions that apply to grazing and harvest of forage after application.

Table 1. Chemical and product name, recommended application rate, soil residual half life, and eco-toxicity of herbicides commonly used to control oxeye daisy. The eco-toxicity is the lethal concentration of the herbicide when applied in a single dose kills 50 percent of the tested organism (the lower the number the more toxic the herbicide). Follow label guidelines for rangeland use and all other label requirements when applying herbicides to avoid damage to desirable plant species.

Chemical name	Product name	Rate per Acre	Half life (days)	Eco-toxicity (LC_{50}/EC_{50})
2,4-D	Many names	1 to 2 qts.	7	1-10 mg/L
Aminopyralid	Milestone	5 to 7 oz.	30	>100 mg/L
Glyphosate	many names	1 to 2 qts.	32	8.2 mg/L
Metsulfuron	Escort/Cimarron	0.5 to 1.5 oz.	14-180	>150 mg/L
Picloram	Tordon 22K/Picloram22	1 pt.	90	10-100 mg/L

[1/] Any mention of products in this publication does not constitute a recommendation by the NRCS. It is a violation of Federal law to use herbicides in a manner inconsistent with their labeling.

Nutrient Management

An unpublished study conducted in the 1970's found repeated application of nitrogen fertilizer was almost as effective in managing oxeye daisy as spraying with 2,4-D or picloram after seven years. Grass yields increased 500% where nitrogen was applied at 80 or 160 lbs./acre and was 2.5 times greater five years after nitrogen applications were discontinued. This suggests that oxeye daisy is not competitive with grasses under high nitrogen conditions. The recommended rate of nitrogen for management of oxeye daisy growing in a stand of competitive grasses is 80 lbs./acre. This also emphasizes the importance of nutrient management in hay fields where oxeye daisy is a threat.

Hand Pulling

Hand pulling, grubbing, and hoeing may be practical on small populations of oxeye daisy and if it is applied persistently can reduce populations. Pulling and grubbing must remove as much of the rhizome as possible to be effective. Follow-up treatments will be necessary where a persistent seed bank or rhizomes exist. Competition and shade will reduce the re-growth of oxeye daisy where manual control is used.

Mowing

In a 28-year study in northern Europe, annual mowing with removal of hay resulted in an increase in oxeye daisy abundance. Mowing with hay removal may favor oxeye daisy by decreasing soil nutrients and reducing a shading canopy. It is recommended that mowing be combined with nutrient management and herbicide management if it is used on pastures infested with oxeye daisy. Mowing at the bud stage of development may reduce seed production, and a British study suggests mowing before seed set may reduce dispersal. Before an herbicide application, mowing may improve herbicide contact with rosettes.

Tilling

Oxeye daisy is not normally a problem in cultivated crop fields because it is controlled by tillage procedures that clean crop fields of weeds. However, because rhizomes have regenerative buds, it is possible to spread oxeye daisy within a crop field and between fields. The long-lived seeds are also believed to be spread with the movement of soil. Repeated tillage or an herbicide application to oxeye daisy plants that regenerate from rhizomes or seeds following tillage will reduce its spread on tilled fields. Cleaning tillage equipment of soil that may contain seeds or rhizomes is recommended after use on fields where oxeye daisy has been growing and before use on weed-free fields.

Prescribed Burning

In a 28-year study, annual spring burning of grassland in Sweden did not affect populations of oxeye daisy. However, there are two considerations where prescribed fire is planned. First, fire exposes bare, mineral soil and favors the germination and establishment of oxeye daisy seeds and seedlings. Second, fire may increase or decrease nitrogen in the soil. Decreased nitrogen favors oxeye daisy over forage grasses in competitive interactions and increased nitrogen may have the opposite effect. To reduce the risk of increased oxeye daisy after prescribed burning, deferred grazing and herbicide management are recommended. Where there are no competitive plants or in forested plant communities where prescribed fire is planned, herbicide management and re-vegetation are recommended along with deferred grazing.

Grazing Control

Cattle (and pigs) avoid grazing oxeye daisy because of its bitter, acrid taste. In Great Britain, oxeye daisy is not common on lightly-grazed meadows, and its abundance is positively related with the intensity of grazing or cutting. Therefore, prescribed grazing management should be a part of oxeye daisy control and prevention on pastures and rangeland. Horses, sheep, and goats graze oxeye daisy; however sheep and goats are more likely than horses to provide population control. It is recommended that sheep or goats be confined to an infestation prior to bloom and removed when 50% of the grass is utilized. Repeated grazing over a number of years may reduce oxeye daisy populations. Periodic herbicide applications may be needed to maintain oxeye daisy below threshold levels. If livestock graze oxeye daisy infestations after bloom, animals should be held for five days and fed weed-free forage before moving to weed-free areas to prevent the spread of viable seeds that pass through the digestive system.

Cultural Control

Plant competition reduces the invasiveness of oxeye daisy and increases the effectiveness of controlled applications. Therefore, practices that increase the competitiveness of desirable plant species and communities such as conservation crop rotation, nutrient management, conservation cover, and critical area planting (for example, after a wildfire) will make the environment less hospitable for oxeye daisy to survive and spread.

Biological Control

Currently, there are no biological control insects available for management of oxeye daisy.

Re-vegetation

Species selected for re-vegetating disturbed sites and oxeye daisy infestations should be appropriate for management objectives, adapted to site conditions, and competitive with the weed. Management objectives will determine if introduced or native species are seeded and the combination of species in the seed mix. The environmental conditions of the site including precipitation, soil texture and depth, slope and aspect, will affect species establishment. Refer to Montana Plant Materials Technical Note 46, 'Seeding Rates and Recommended Cultivars,' and Extension Bulletin EB19 'Dryland Pasture Species for Montana and Wyoming' for seeding rate guidance and re-vegetation species selection. State, area, and field office resource specialists can help determine the most appropriate, site-specific species mix and timing of seeding.

In most cases, herbicidal suppression of oxeye daisy is needed for re-vegetation of infested lands. The herbicides listed in Table 1 will control oxeye daisy and reduce competition during the establishment period with little or no injury to emerging grass seedlings. This is especially important for species that are slow to establish like many of the native grasses. However, where herbicides have been applied, chemical carryover should be assessed prior to planting permanent vegetation, particularly if forbs or shrubs are included in the seed mix.

It is noteworthy that a six-year field diversity study in the Netherlands found oxeye daisy population stability measured by biomass decreased as diversity increased. The diversity make-up of this study included combinations four grass and four forb species, all perennials. In the last year of the study, oxeye daisy almost disappeared from the plots. Light intensity at the soil surface decreased as diversity increased, and soil nutrient concentrations were either not affected (phosphate) or showed a slight increase (potassium and nitrate) with diversity. In monocultures of oxeye daisy, fewer weeds were successful invaders than in monocultures of the other seven species. This study suggests that restoring and maintaining diverse plant communities may reduce invasiveness of this weed, and the suppression of oxeye daisy is important for successful re-vegetation with desirable species.

Integrated Pest Management

Integrated pest management is the application of two or more management alternatives that are complimentary in weed suppression, increase the longevity of control procedures, and improve crop production or conservation of resources. The integration of multiple management practices should be designed based on the stage of oxeye daisy invasion. On populations in the early phase of invasion, aggressive herbicidal or hand control should be combined with cultural practices that strengthen the competitiveness of the plant community including the application of 80 lbs./acre nitrogen on non-native pastures and haylands. In areas with large-scale infestations in the later phases of invasion, first priority should be given to herbicide application to eradicate small, satellite populations and to reduce spread along the invasion front of the parent population. Second priority should be given to reducing the parent population using herbicide management, nitrogen addition to grass communities, and re-vegetation with competitive plants where needed. On grazing lands, prescribed grazing management using multiple species should be timed to maintain the vigor of rangeland plants and prevent oxeye daisy seed spread. On crop

and hay land in rotation, tillage combined with herbicide treatment will be more effective than either of the treatments applied alone, and a nutrient management plan should be followed. On disturbed sites, pastures, and rangeland where competitive plants have been lost, re-vegetation following control of oxeye daisy will improve the longevity of the control application.

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