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VEGETATION MANAGEMENT GUIDELINE

White Sweet Clover (*Melilotus alba* Medik.)
Yellow Sweet Clover (*Melilotus officinalis* (L.) Pallas)

SPECIES CHARACTER

DESCRIPTION

White and yellow sweet clovers are taprooted, erect or ascending annual, biennial or short-lived perennial herbs that are somewhat easy to identify, especially when in flower. The stems are highly branched and up to 1.5 m (5 feet) tall. The leaves are alternate and pinnately trifoliate with the middle leaflet having a short stalk. The leaflets are oblong, 1 - 4 cm (3/8 - 1 1/2 inch) long with entire margins except for small teeth at the tip. The small, pea-like, white or yellow flowers are 4 - 5 mm (1/8 inch) long and densely crowded on a 10 cm (4 inch long) spike. Each spike may have 40 - 120 flowers arranged in one-sided racemes with the younger flowers nearest the tip. The fruit is a legume that is 2.5 - 5 mm (1/16 - 1/8 inch) long and usually has one seed although some may have two or three seeds. Each legume is attached to the stem by a minute stalk. Mature (second-year) plants may appear bushy. These aromatic plants are members of the pea (legume) family, but are not true clovers.

SIMILAR SPECIES

White and yellow sweet clovers are distinguished from other members of the pea family by the shape of the inflorescence and the root system. The leaves of yellow and white sweet clover are divided into three leaflets that are finely toothed at the tip, a middle leaflet that occurs on a distinct stalk, and flowers that occur in a long narrow inflorescence. True clovers (*Trifolium* spp.) lack a tap root and have flowers in round, hemispherical, or cylindrical heads, head-like racemes or umbels. Alfalfa (*Medicago sativa*) has blue flowers. Sweet clover should be accurately identified before attempting any control measures. If identification of the species is in doubt, the plant's identity should be confirmed by a knowledgeable individual and/or by consulting appropriate manuals or keys.

DISTRIBUTION

Sweet clover is native to Europe and Asia. It now occurs in all 50 United States and much of Canada. White sweet clover was first introduced into North America in 1664. Yellow sweet clover was first reported in North America in 1739. In the early 1900's, sweet clover was cultivated as a forage and hay crop and soil builder. Today it also is used as a wildlife cover crop and in production of honey. Each species of sweet clover has been recorded from every county in Illinois, and adventive populations occur in disturbed habitats throughout most of the state. Since this exotic is considered economically important, and will continue to be planted, it will remain a problem for land managers well into the future.

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HABITAT

Sweet clovers are adapted to a variety of conditions and habitats and often increase following disturbances including burning and brush removal. Sweet clover seems to prefer calcareous or loamy soils with a pH level of 6.5 or greater. It frequently occurs in strip-mined land, oil field sites, pastures, abandoned fields, on open, gravelly riverbanks that experience brief spring flooding and along roadways and railways. It grows well in direct sunlight, but is intolerant of full shade. A thick growth of a second-year sweet clover produces enough shade to cause its own lower leaves to fall. Sweet clovers require sufficient moisture for establishment, but are not tolerant of continuous flooding. Once established, sweet clovers are very drought tolerant. Open natural communities including prairies, barrens, savannas, meadows, and glades are most susceptible to sweet clover invasion.

LIFE HISTORY

Sweet clovers usually grow as biennials, putting their energy into root development during the first growing season and into flower and seed production the second season. However, sweet clovers can also grow as annuals or short-lived perennials. As a biennial or short-lived perennial, sweet clovers are entirely vegetative the first growing season during which a small, branched stem with clover-like leaves is visible. In late summer, the root continues to develop. First-year white sweet clover plants have a "critical growth period" at the end of summer, when rapid root growth and food storage take place. This begins about September 1 in the Midwest. Following this growth period, the plant develops contractile roots that pull the root crowns below the soil surface allowing it to survive the winter.

By the second year, sweet clovers have strong taproots and root crowns from which new shoots emerge. Taproots of second-year plants may exceed 120 cm (50 inches) in depth. The plants flower from May through September. Bees, wasps, and flies are the primary pollinators, but self-pollination is also possible. Sweet clovers are prolific seed producers with each plant capable of producing 14,000 to 350,000 seeds per plant. The small, hardy seeds are shed in the fall and are dispersed by gravity, strong winds, water, and animals. The seeds float, and thus rain wash and stream flow may be an important means of dispersal. The seeds are eaten by numerous species of birds and small mammals and are especially common in the diets of quail and partridge. The seeds have a hard seed coat that must be scarified for germination to occur. Scarification occurs through fluctuating freezing and thawing temperatures or by heat from a fire. The seeds may remain dormant and viable in the seedbank for 30 years or more. Sweet clovers do not reproduce vegetatively in nature, so seed production is critical for its continued existence and is the key to controlling it. If the flowering stage of sweet clover is halted, so is the spread of the plant - as long as management procedures continue long enough to deplete viable seeds remaining in the soil.

EFFECTS UPON NATURAL AREAS

Sweet clovers readily invade open habitats and have successfully exploited many Midwestern native prairies and open, unflooded communities.

CONTROL RECOMMENDATIONS

RECOMMENDED PRACTICES IN NATURAL COMMUNITIES OF HIGH QUALITY

Mechanical

First-year plants cut just prior to the start of the "critical growth period" may experience high rates of winter mortality. In Ohio, plants cut on September 9 experienced winter kill mortality rates of 75%, plants cut on September 26 - 53% winter kill, and on November 3 - 12%. Only 5% of the plants that were not cut experienced winter kill. Additionally, clipped plants that survived the winter showed poor vigor the following spring, and many died during the summer of their second year. Cutting can also reduce seed production in second year plants if it is initiated prior to flowering and is conducted several times during the growing season. Low branches on cut or mowed stems can still produce flowers and seeds.

Hand-pulling is effective if done when the ground is moist and most of the root can be removed, but is laborious and probably should not be attempted by those with a histroy of back problems. For best results, hand-pulling should be done in the late fall, after the rootcrown buds from first-year plants have developed, or early spring, before second year plants develop flower buds. Fall weeding of first-year plants is recommended because: 1) the bright green sweet clover is easily spotted within the yellowing prairie, 2) moist soil conditions may make pulling easier, and 3) fall weeding is less stressful to native vegetation. However, sweet clover is easily located in the spring also, because it becomes green earlier than most native prairie vegetation.
Hand-pulling in summer can be effective if done when the ground is moist. Hand-pulling is labor-intensive and must be done consistently. This treatment is feasible for light and moderate infestations, but may be too time consuming in heavy infestations.

As the plants mature after flowering, the stems become brittle and can be easily snapped off near ground level. This can be an effective control measure provided it is done before the seeds are fully mature and legumes begin to open and the plant material is removed from the site.

Prescribed burning

Prescribed burning can be effective if properly timed and conducted in subsequent years. On newly infested areas, a combination of an April burn in the first year, followed by a May burn the following year is most successful for eradicating an even-aged stand of sweet clover. A hot, complete, first-year April burn scarifies soil-borne sweet clover seeds, stimulating them to germinate. A late fall burn will also have this effect. Actively growing second-year plants are easily killed by fire and a hot, complete, second-year May burn will kill the elongated shoots before they can produce seed. Burning of a remnant tallgrass prairie in Minnesota on May 1, when second-year white sweet clover plants were 5-15 cm (2 to 6 inches) tall, resulted in the virtual elimination of second-year plants from the site. July burning on another portion of the same prairie eliminated all first- and second-year plants. In grass-dominated old fields in eastern North Dakota, late June burning eradicated second-year white sweet clover plants.

New seedlings can emerge almost any month during the growing season, but seedlings that emerge in summer or fall have a higher winter mortality rate than spring-emerged seedlings. Burns conducted prior to shoot elongation will not damage the sweet clover shoots. Heavily infested stands are best controlled when the above sequence is repeated following a year without burning. This method is less effective if the burn is patchy, leaving viable seeds or second-year shoots unscathed. Fall mowing can speed up the burn program: burn in April; mow first-year plants in August, leaving the stems behind to dry; and burn again in mid-late September.

In established sweet clover stands, plants present as buds on the caudex may survive dormant-season burns, as the caudex is located about 5 cm (2 inches) below the ground surface. On the Curtis Prairie in Wisconsin, second-year white sweet clover plants were abundant in the spring following dormant season fall burns. If second year plants are not killed or removed, they will produce seed. In this case, a combination of other procedures can be used: 1) spring burns could be later (after shoots elongate, but before second-year plants set seed) in a sequence of 3-5 years, or 2) follow up the early burn with hand-pulling or herbicide applications, if practical.

Herbicides

Clopyralid (tradename Stinger, Transline) and triclopyr (tradename Garlon 3A, Tahoe 3A) are broadleaf specific herbicides and are appropriate options in areas dominated by native grasses. For Stinger and Transline, mix of 7.3 ml (1/4 ounce) of herbicide per gallon of water for each 1,000 square feet of coverage area. For Garlon 3A and Tahoe 3A, mix 14.6 ml (1/2 ounce) herbicide per gallon of water for each 1,000 square feet of coverage area. Triclopyr needs the addition of 0.5% non-ionic surfactant. Do not apply Stinger, Roundup or Rodeo if rain is expected within six hours after application. Garlon 3A and Tahoe 3A are rainfast in three hours; Transline in two hours.

Apply herbicides only to actively growing plants. Precautions should be taken to avoid contacting non-target plants with the solution. When applying herbicides described above, spot application should be done such that coverage is uniform with the entire leaf being wet. **Do not spray so heavily that herbicide drips off the target species.** Apply herbicide solution while moving out of the treated area. By law herbicides may only be applied according to label instructions and by licensed herbicide applicators or operators when working on public properties.

RECOMMENDED PRACTICES ON BUFFER AND SEVERELY DISTURBED SITES

Same as given above for high quality areas, with the following addition:

Glyphosate (tradename Accord, Rodeo, Roundup) is a non-selective systemic herbicide that will control most annual and perennial plants. A 2% solution (80 ml or 2.7 ounces per gallon of water) is recommended for Accord, Rodeo and Roundup. When possible, apply glyphosate herbicides in spring before native vegetation emerges.

BIOLOGICAL CONTROL

Little research has been conducted for biological control of sweet clovers because of their importance to the agricultural industry. However, several species of insects and bacteria cause damage to sweet clovers. Among these the most destructive is the sweet clover borer (*Sitona cylindricollis*). The larvae of this insect feed on the sweet clover roots while the adults feed on foliage. Early spring or fall feeding by weevils may be severe enough to kill plants. The sweet clover root borer (*Walshia miscecolorella*) is a native moth whose larvae have, on rare occasions, reached densities that have damaged sweet clover stands over large areas. The ashgray blister beetle (*Epicauta fabricii*), striped blister beetle (*E. vittata*) and marginated blister beetle (*E. pestifera*) will feed on sweet clover, but do not inflict significant damage. The bacterium *Rhizoctonia* sp. causes root rot in sweet clovers but it also infects soy beans, potatoes, sugar beets, ornamentals and turf grasses.

FAILED OR INEFFECTIVE PRACTICES

A single prescribed burn, mowing, or pulling is not an effective for control of sweet clover. A single burn will result in greater seed germination, more plants during the growing season and, thus, more seeds in the seedbank if the plants are left to produce seed.

The flowering period is extended if sweet clover is cut in the late bud stage of growth and small stems may still produce seeds.

Sweet clovers are palatable and nutritious. Livestock including cattle, horses, and sheep will graze on young sweet clover plants and sweet clover hay. Sweet clover that is grazed when root buds are forming (September through early October) or to less than 6-inch tall has decreased stem and seed production the following year.

Although grazing and haying can reduce seed production in sweet clover, they are not recommended as effective control measures. Grazing must be quite heavy, 3 to 4 head of cattle per acre, to prevent the crop from flowering and would likely result in excessive damage to more desirable species. Also, grazing is most effective when plants are 30 cm (12 inches) tall and continues throughout the growing season. Older plants become woody and have higher levels of coumarin, a chemical that causes a bitter taste in them, decreasing palatability as the plants age.

For haying to be effective, the initial cutting must be implemented while sweet clover flowers are in the bud stage to reduce the risk of seed production. A subsequent cutting or haying should be done later in the season to eliminate stems that may flower after the initial haying. Sweet clover hay must be allowed to dry thoroughly before it is baled. Moldy, partially cured hay can produce dicoumarol, a toxic substance that results from the conversion of nontoxic coumarin by fungi. Dicoumarol causes hemorrhagic syndrome when ingested by cattle. Equipment and livestock may serve as dispersal and disturbance mechanisms that can promote the spread of sweet clover.

REFERENCES

Barnes, R.F., Miller, D.A. and Nelson, C.J. eds. Forages, 5th ed, Vol. 1, An Introduction to Grassland Agriculture. Iowa State University Press, Ames, Iowa, pp. 273-281.

Butterfield, C., J. Stubbendieck, and J. Stumpf. 1996. Species abstracts of highly disruptive exotic plants. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. Available at: http://www.npwrc.usgs.gov/resource/othrdata/exoticab/exoticab.htm (Version 16JUL97). Accessed: October 5, 2005.

DiTomaso, J.M., M.L. Brooks, E.B. Allen, and R. Minnich. 2005. The Use of Fire as a Tool for Controlling Invasive Weeds. D. Johnson ed. Center for Invasive Plant Management, Bozeman, MT. Available at: http://www.cal-ipc.org/file_library/19050.pdf. Accessed: October 5, 2005.

Eckardt, N. 1987. The Nature Conservancy's element stewardship abstract for *Melilotus alba* and *Melilotus officinalis*.

Hanson, E. 1987. *Melilotus alba* control on a prairie remnant (Illinois). Restoration and Management Notes. 5(1):26.

Kline, V.M. 1984. Response of sweet clover (*Melilotus alba* Desr.) and associated prairie vegetation to seven experimental burning and mowing treatments. Proceedings of the 9th North American Prairie Conference. pp. 149-152.

Mohlenbrock, R.H. and D.M. Ladd. 1978. Distribution of Illinois vascular plants. Southern Illinois University Press, Carbondale. 281pp.

Rhykerd, C.L. and B.J. Hankins. 1982. Sweet clover production and utilization in Indiana. Agronomy Department, Purdue University, Cooperative Extension Service, West Lafayette, IN 47907. available at: http://www.agry.purdue.edu/ext/forages/publications/ay233.htm. Accessed: October 6, 2005.

Tu, M., Hurd, C. & J.M. Randall. 2001. Weed Control Methods Handbook, The Nature Conservancy, http://tncweeds.ucdavis.edu, version: April 2001. Accessed: October 6, 2005.

Turkington, R. A., P. B. Cavers, and E. Rempel. 1978. The biology of Canadian weeds: 29. *Melilotus alba* Desr. and *M. officinalis* (L.) Lam. Canadian Journal of Plant Science 58:523-537.

Uchytil, Ronald J. 1992. *Melilotus alba*. In: Fire Effects Information System, [Online]. U.S.D.A., Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis. Accessed October 5, 2005.

USDA, NRCS. 2001. The PLANTS Database, Version 3.1, National Plant Data Center, Baton Rouge, LA 70874-4490 USA. Available at: http://plants.usda.gov. Accessed: October 5, 2005.

White D.J., E. Haber and C. Keddy. 1993. Invasive plants of natural habitats in Canada: an integrated review of wetland and upland species and legislation governing their control. Canadian Wildlife Service, Ottawa, Canada. 121 p. Available at: www.cws-scf.ec.gc.ca/publications/inv/14_e.cfm. Accessed October 5, 2005.

PERSONAL COMMUNICATION

Glass, Bill. 1989. Division of Natural Heritage, Illinois Department of Conservation, Springfield, Illinois.

Laurie, Dennis. 1989. Lake County Forest Preserve District, Libertyville, Illinois.

Schwegman, John. 1989. Division of Natural Heritage, Illinois Department of Conservation, Springfield, Illinois.

Packard, Steve. 1989. The Nature Conservancy, Chicago, Illinois.

Written for the Illinois Nature Preserves Commission by:

Maggie Cole
Illinois Department of Conservation
100 First National Bank Plaza
Suite 205
Chicago Heights, Illinois 60411

Revised in 2006 for the Illinois Nature Preserves Commission by:
Bob Edgin
Illinois Nature Preserves Commission
9940E 500th Ave,
Newton, IL 62448