Oregon Department of Agriculture
Plant Pest Risk Assessment for
Wooly Distaff Thistle, Smooth Distaff Thistle
Carthamus lanatus, C. baeticus
2010

Name: Wooly distaff thistle, *Carthamus lanatus* a.k.a. distaff thistle, saffron thistle, smooth distaff thistle, *Carthamus baeticus* a.ka. distaff thistle
Family: Aster, *Asteraceae*

Findings of This Review and Assessment: Distaff thistles, *Carthanus lanatus, C. baeticus*, were evaluated and determined to be category **"A"** rated noxious weeds, as defined by the Oregon Department of Agriculture (ODA) Noxious Weed Policy and Classification System. This determination was based on a literature review and analysis using two ODA evaluation forms. Using the Noxious Qualitative Weed Risk Assessment v.3.8, distaff thistles scored **69** indicating a Risk Category of **A**; and a score of **18** with the Noxious Weed Rating System v.3.2, indicating a **"A"** rating.

Distaff thistle flower, photo by Ken French, ODA

Distaff thistle infestation in Australia, photo by Dennis Isaacson, ODA

Introduction: Wooly distaff thistle, *Carthamus lanatus*, is a USDA federally listed noxious weed and can be considered one of the worst pasture weeds in North America and Australia (Briese, D. T. 1988; Burrill, L.C. 1994). It is a highly adaptable member of the aster family, heavily armed with spines and producing an abundance of moderately long-lived seeds. In dense infestations, it imposes significant impediments to forage production and quality meanwhile creating physical barriers to grazing access (Burrill, L. C. 1992). First reported in California in 1891 south of San Francisco, it has since become widespread in that region where it infests thousands of acres of seasonally dry hillside pasture (Hickman, J. C. 1993). In Oregon, the first infestation was identified in 1987, with infestations now occuring in three counties in southwest Oregon.

Smooth distaff thistle, *Carthamus baeticus,* is also a USDA federally listed noxious weed. It was first reported in California in 1914 in the San Joaquin Valley. Easily confused with wooly distaff thistle, it is now identified in the17 Counties of North-central and Southern California (DiTomaso 2004 and 2006; Robbins et. al. 1951). There are no reported sites in Oregon. It grows and inhabits the same habitat as wooly distaff thistle creating the same economic impacts.

Growth Habits, Reproduction, and Spread: Woolly distaff thistle is a yellow-flowering, spiny, winter annual characterized by a silver-green appearance when young and stout spines on the flower heads and leaves (DiTomaso 2006; Hickman, J. C. 1993). It is very closely related to safflower and is often confused with the commercially produced plant when located in the field (Abrams, L. and Ferris, R. S. 1961). The genetic similarities between the two species are so great that biological control has not been pursued in the United States.

Photos by Ken French, ODA

Large plants take on a candelabra-shaped structure, very distinguishable from other thistle species. Older, straw-colored stems are distinctly branched in the upper 2/3rd of the plant, and are usually covered with loose, wooly, cobwebby, and glandular hairs, especially in leaf axils and at bases of flower heads. They generally reach a height of 3' though they are capable of setting seed from very short plants.The rosettes are spined and form the flattened circular shape common in many asteraceae species (see photo). Yellow flowers bloom from July to September in Oregon (Burrill, L.C. 1994; DiTomaso 2006).

Smooth distaff thistle species forms yellow flowers from July to August in California. Noticeably less hairy than wooly distaff thistle, the stems are white to straw-colored, distinctly branched in the upper 2/3rd of the plant, and are sparsely covered with wooly and minute glandular hairs, especially at the bases of flower heads (Abrams, L. and Ferris, R. S. 1961; DiTomaso 2006). As a closely related species, smooth distaff thistle, is difficult to distinguish from its cousin and is sometimes classified as subspecies of *C. lanatus*. Current taxonomy in North America, documents each as distinct species due to gene numbers (smooth distaff thistle: 2n = 64, wooly distaff thistle: 2n = 44) and the fact that the species have not been observed hybridizing (Peirce J. R. 1990). Biologically, they behave the same in the natural environment and can be treated the same from a management perspective. Dominant in heavily grazed, seasonally dry pastures, distaff population densities can become quite significant, forming nearly impenetrable thickets excluding livestock from adjacent forage (Grace 2002). Habitat availablility in Califonia and SW Oregon is huge covering millions of acres indicating the need for effective early detection and treatment programs to prevent the serious economic impacts created by their expansion (Burrill 1994; DiTomaso 2006).

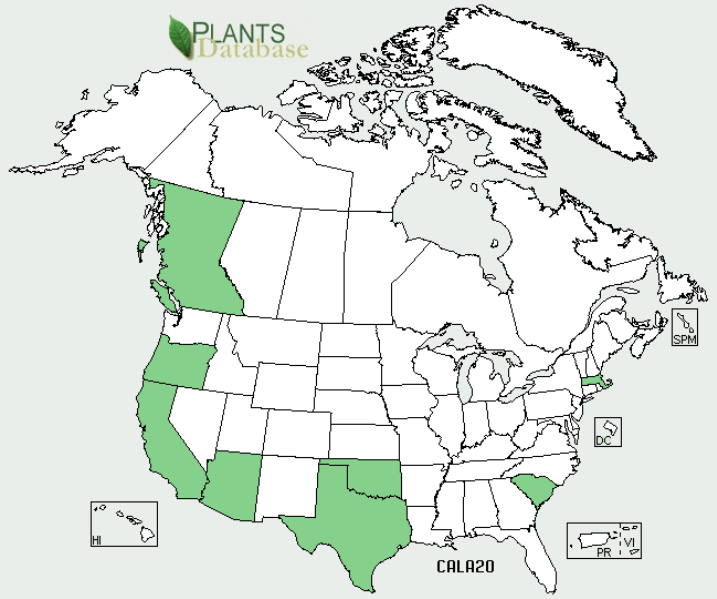
Distaff thistles take advantage of early, growing season moisture to germinate and establish before the dry season sets in. A deep-growing taproot draws water deeper in the soil profile allowing them to grow, flower and set seed after annual grasses have become dormant (Burrill, L.C. 1994; Grace 2002). Seed production is abundant though the large seeds are not wind dispersed, often dropping close to the plant or remaining in the flowerhead for extended periods, facilitating their spread by livestock and human activities season-long (Burrill, L.C. 1994). Seeds can lay dorment in the soil until conditions are ideal for seedling survival (Grace et. al. 2002)

Dispersal: The movement of livestock and contaminated forage or contaminated pasture seed all have been significant factors in distaff dispersal. Vehicle traffic has also contributed in a minor way to distaff dispersal. Birds and wildlife movement may also contribute to local dispersal (Grace 2002).

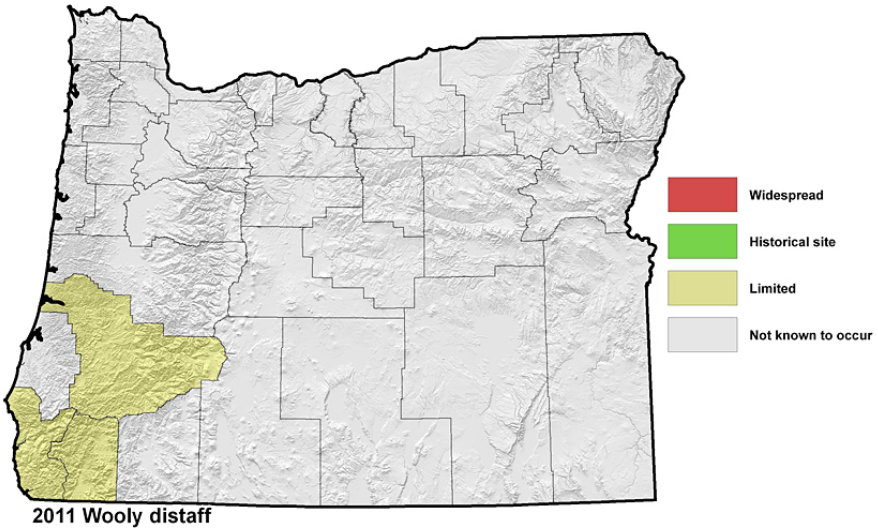
Native Range: Distaff thistles originated in the Middle East, and the Central and Mediterranean areas of Europe and Western Asia (Hickman, J. C. 1993).

Distribution in North America: Distaff thistles occurs in three counties in southwest Oregon, Douglas, Josephine, and Curry Counties (French 2009). It is widespread in California and is reported to be in numerous locations in Texas, Arizona, Oklahoma, Massachusetts, South Carolina, and Canada (British Columbia) (Hickman, J. C. 1993; Burrill, L.C. 1994).

Probability of Detection in Oregon: Distaff thistles is not exceptionally showy and there are other yellow-flowered thistle-like species that may confuse non-botanists and livestock producers. The species are also capable of being transported miles from parent populations by livestock transport or wildlife movement into areas not frequented anually by humans. New populations may establish and expand for years before they are located and treated. This has happened in several incidences in southwest Oregon (Pers. Comm., Ken French, 2010).



US distribution of wooly distaff thistles on Plants Database



Oregon's distribution of wooly distaff thistle on WeedMapper

Negative Economic Impact: Wooly distaff thistle can drastically decrease forage availability for grazing animals where heavy infestations occur (Burrill, L.C. 1994; DiTomaso 2006). Prime hillside pasture, valuable to commercial sheep operations, are invaded in Oregon and California. Yearly weed control efforts are essential to maintaining productivity of these lands. These efforts are expensive and add additional production costs to these operations. It is reportedly Australia's worst rangeland thistle and has also been known to infest cereal grain fields where dense infestations have reduced yields, clogged harvesting equipment, and increased seed cleaning costs (Fromm, G. M. 1990; Grace 2002). The mature dead plants stay rigid and spiny even after they mature and die, leaving large areas where the forage is not utilized throughout the entire year. In Australia, distaff thistle spines cause contamination and down-grading of wool, and physical injury to sheep shearers. The biomass left on the infested areas significantly can increase fuel loads for wildfire, increasing fire danger during the summer (Grace 2002; Sindel, B. M. 1991).

Positive Economic Impact: Distaff thistles has no positive economic value.

Ecological Impacts: Reduces foraging areas available to most wildlife and livestock (Burrill, L.C. 1994). Rosettes are prostrate with sharp spines and are not easily grazed. By the time the plant produces flowers, it is so rigid and spiny that grazing animals and wildlife try to avoid contact. The spiny leaves and flower bracts can injure the mouths and eyes and mouths of animals forced to graze densely infested pastures (Pers. Comm., Ken French, 2010). Because the seeds are relatively large and heavy, most fall close to the plant. Some seeds remain on the plants even after the plants mature and die, and are available for spread by equipment, livestock and wildlife throughout the year. During the fall and winter distaff seeds provide a food source for some native birds (www.informedfarmer.com; ODA personal observation).

Control: Production and spread of seed must be halted. Seeds can last over 10 years in the soil, making long term control challenging. Plants should be killed annually with a selective herbicide or cut just below the soil and removed from the field prior to flowering (Peachey et. al). Mowing can be effective if done just before flowering, with dry soils, but if the soil moisture is high, mowing is only minimally effective as the plants usually re-grow and flower. Plants are easier to control when immature, however individual plants are often hard to see until the surrounding pasture/forage starts to dry. Distaff thistle is highly immune to grazing from either animals or invertebrates. It is able to express its full biological potential in North America except in pastures with dense perennial grasses. The grass competition makes these areas are less susceptible to invasion from and may also reduce plant vigor.

In 1997, biological control specialists in France presented strong phenological and practical evidence (field records, plus results of host specificity tests) to support biological control for wooly distaff thistle. Their work documented the fact that the three phytophagous species may be considered as specifically attacking *C. lanatus*, but without damaging field crops of its close relative, *C. tinctorius*. Authors discussed that contrary to traditional beliefs; biological control may therefore be considered a promising, safe approach for reducing *C. lanatus* populations. No biological control for wooly distaff thistle has been pursued in the United States to date (Pers. Comm., Eric Coombs, Jan. 2012).

Noxious Weed Qualitative Risk Assessment
Oregon Department of Agriculture

Common name: Wooly distaff thistle, smooth distaff thistle
Scientific name: *Carthanus lanatus, C. baeticus*
Family: Aster, *Asteraceae*

For use with plant species that occur or may occur in Oregon to determine their potential to become serious noxious weeds. For each of the following categories, select the number that best applies. Numerical values are weighted to increase priority categories over less important ones. Choose the best number that applies, intermediate scores can be used.

Total Score: 54 **Risk Category: B**

GEOGRAPHICAL INFORMATION

1) 6 Invasive in Other Areas

0 Low- not know to be invasive elsewhere.
2 Known to be invasive in climates dissimilar to Oregon's current climates.
6 Known to be invasive in geographically similar areas.

Comments: Invasive in similar climates in Australia, California

2) 6 Habitat Availability: Are there susceptible habitats for this species and how common or widespread are they in Oregon?

1 *Low* – Habitat is very limited, usually restricted to a small watershed or part of a watershed (e.g., tree fern in southern Curry County).
3 *Medium* – Habitat encompasses 1/4 or less of Oregon (e.g., oak woodlands, coastal dunes, eastern Oregon wetlands, Columbia Gorge).
6 *High* – Habitat covers large regions or multiple counties, or is limited to a few locations of high economic or ecological value (e.g., threatened and endangered species habitat).

Comments: Endangered habitat is large covering many agricultural counties in western and eastern Oregon.

3) 0 Proximity to Oregon: What is the current distribution of the species?

0 *Present* – Occurs within Oregon.
1 *Distant* – Occurs only in distant US regions or foreign countries.
3 *Regional* – Occurs in Western regions of US but not adjacent to Oregon border.
6 *Adjacent* – Weedy populations occur adjacent (<50 miles) to Oregon border.

Comments: Occurs in western Oregon.

4) 10 Current Distribution: What is the current distribution of escaped populations in Oregon?

0 *Not present* – Not known to occur in Oregon.
1 *Widespread* – Throughout much of Oregon (e.g., cheatgrass).
5 *Regional* – Abundant (i.e., occurs in eastern, western, central, coastal, areas of Oregon) (e.g., gorse, tansy ragwort).
10 *Limited* – Limited to one or a few infestations in state (e.g., kudzu).

Comments: Limited to a dozen infestations in southwest Oregon.

BIOLOGICAL INFORMATION

5) 4 **Environmental Factors**: Do abiotic (non-living) factors in the environment effect establishment and spread of the species? (e.g., precipitation, drought, temperature, nutrient availability, soil type, slope, aspect, soil moisture, standing or moving water).

1 *Low* – Severely confined by abiotic factors.
2 *Medium* – Moderately confined by environmental factors
4 *High* – Highly adapted to a variety of environmental conditions (e.g., tansy ragwort, Scotch broom).

Comments: Highly adaptable species.

6) 5 **Reproductive Traits:** How does this species reproduce? Traits that may allow rapid population increase both on and off site.

0 *Negligible* – Not self-fertile, or is dioecious and opposite sex not present.
1 *Low* – Reproduction is only by seed, produces few seeds, or seed viability and longevity are low.
3 *Medium* – Reproduction is vegetative (e.g., by root fragments, rhizomes, bulbs, stolons).
3 *Medium* – Produces many seeds, and/or seeds of short longevity (< 5 years).
5 *High* – Produces many seeds and/or seeds of moderate longevity (5-10 years) (e.g., tansy ragwort).
6 *Very high* – Has two or more reproductive traits (e.g., seeds are long-lived >10 years and spreads by rhizomes).

Comments: Produces an abundace of long-lived seeds.

7) 4 **Biological Factors:** Do biotic (living) factors restrict or aid establishment and spread of the species? (What is the interaction of plant competition, natural enemies, native herbivores, pollinators, and pathogens with species?)

0 *Negligible* – Host plant not present for parasitic species.
1 *Low* – Biotic factors highly suppress reproduction or heavily damage plant for an extended period (e.g., biocontrol agent on tansy ragwort).
2 *Medium* – Biotic factors partially restrict or moderately impact growth and reproduction, impacts sporadic or short-lived.
4 *High* – Few biotic interactions restrict growth and reproduction. Species expresses full growth and reproductive potential.

Comments: Expresses full biological potential. Resistant to herbivory, very competetive.

8) 3 **Reproductive Potential and Spread After Establishment - Non-human Factors:** How well can the species spread by natural means?

0 *Negligible* – No potential for natural spread in Oregon (e.g., ornamental plants outside of climate zone).
1 *Low* – Low potential for local spread within a year, has moderate reproductive potential or some mobility of propagules (e.g., propagules transported locally by animals, water movement in lakes or ponds, not wind blown).
3 *Medium* - Moderate potential for natural spread with either high reproductive potential or highly mobile propagules (e.g., propagules spread by moving water, or dispersed over longer distances by animals) (e.g., perennial pepperweed).

5 *High* – Potential for rapid natural spread throughout the susceptible range, high reproductive capacity and highly mobile propagules. Seeds are wind dispersed over large areas (e.g., rush skeletonweed).

Comments: Comments: Seeds require animals or human for transport. Not wind-blown.

9) 5 **Potential of Species to be Spread by Humans**. What human activities contribute to spread of species? Examples include: interstate or international commerce; contaminated commodities; packing materials or products; vehicles, boats, or equipment movement; logging or farming; road maintenance; intentional introductions of ornamental and horticultural species, or biofuel production.

1 *Low* – Potential for introduction or movement minimal (e.g., species not traded or sold, or species not found in agricultural commodities, gravel or other commercial products).

3 *Medium* – Potential for introduction or off-site movement moderate (e.g., not widely propagated, not highly popular, with limited market potential; may be a localized contaminant of gravel, landscape products, or other commercial products) (e.g., lesser celandine, Canada thistle).

5 *High* – Potential to be introduced or moved within state high (e.g., species widely propagated and sold; propagules common contaminant of agricultural commodities or commercial products; high potential for movement by contaminated vehicles and equipment, or by recreational activities) (e.g., butterfly bush, spotted knapweed, Eurasian watermilfoil).

Comments: High potential for transport by humans in agricultural activities.

IMPACT INFORMATION

10) 10 **Economic Impact**: What impact does/can the species have on Oregon's agriculture and economy?

0 *Negligible* – Causes few, if any, economic impacts.

1 *Low* - Potential to, or causes low economic impact to agriculture; may impact urban areas (e.g., puncture vine, pokeweed).

5 *Medium* – Potential to, or causes moderate impacts to urban areas, right-of-way maintenance, property values, recreational activities, reduces rangeland productivity (e.g., English ivy, Himalayan blackberry, cheatgrass).

10 *High* – Potential to, or causes high impacts in agricultural, livestock, fisheries, or timber production by reducing yield, commodity value, or increasing production costs (e.g., gorse, rush skeleton weed, leafy spurge).

Comments: Can cause severe economic losses to a wide range of agronomic commodities.

11) 6 **Environmental Impact**: What risks or harm to the environment does this species pose? Plant may cause negative impacts on ecosystem function, structure, and biodiversity of plant or fish and wildlife habitat; may put desired species at risk.

0 *Negligible* – None of the above impacts probable.

1 *Low* – Can or does cause few or minor environmental impacts, or impacts occur in degraded or highly disturbed habitats.

4 *Medium* – Species can or does cause moderate impacts in less critical habitats (e.g., urban areas, sagebrush/ juniper stands).

6 *High* – Species can or does cause significant impacts in several of the above categories. Plant causes severe impacts to limited or priority habitats (e.g., aquatic, riparian zones, salt marsh; or T&E species sites).

Comments: Can cause serious impacts to grasslands, savanahs, rangeland.

12) 2 **Impact on Health:** What is the impact of this species on human, animal, and livestock health? (e.g., poisonous if ingested, contact dermatitis, acute and chronic toxicity to livestock, toxic sap, injurious spines or prickles, causes allergy symptoms.

0 *Negligible* – Has no impact on human or animal health.
2 *Low* – May cause minor health problems of short duration, minor allergy symptoms (e.g., leafy spurge).
4 *Medium* – May cause severe allergy problems, death or severe health problems through chronic toxicity, spines or toxic sap may cause significant injury. (e.g., giant hogweed, tansy ragwort).
6 *High* – Causes death from ingestion of small amounts, acute toxicity (e.g. poison hemlock).

Comments: Impacts minor relating to allergies or mechanical injury from thorns.

CONTROL INFORMATION

13) 5 **Probability of Detection at Point of Introduction**: How likely is detection of species after introduction and naturalization in Oregon?

1 *Low* – Grows where probability of early detection is high, showy and easily recognized by public; access to habitat not restricted (e.g., giant hogweed).
5 *Medium* – Easily identified by weed professionals, ranchers, botanists; some survey and detection infrastructure in place. General public may not recognize or report species (e.g., leafy spurge).
10 *High* – Probability of initial detection by weed professionals low. Plant shape and form obscure, not showy for much of growing season, introduction probable at remote locations with limited access (e.g., weedy grasses, hawkweeds, skeletonweed).

Comments: Plant thorny, showy when in bloom and easily identified by weed professionals, landowners, land managers.

14) 3 **Control Efficacy:** What level of control of this species can be expected with proper timing, herbicides, equipment, and biological control agents?

1 *Negligible* – Easily controlled by common non-chemical control measures (e.g., mowing, tillage, pulling, and cutting; biocontrol is very effective at reducing seed production and plant density) (e.g., tansy ragwort).
2 *Low* – Somewhat difficult to control, generally requires herbicide treatment (e.g., mechanical control measures effective at preventing flowering and but not reducing plant density; herbicide applications provide a high rate of control in a single application; biocontrol provides partial control).
4 *Medium* – Treatment options marginally effective or costly. Tillage and mowing increase plant density (e.g., causes tillering, rapid regrowth, spread from root fragments). Chemical control is marginally effective. Crop damage occurs or significant non-target impacts result from maximum control rates. Biocontrol agents ineffective.
6 *High* – No effective treatments known or control costs very expensive. Species may occur in large water bodies or river systems where containment and complete control are not achievable. Political or legal issues may prevent effective control.

Comments: Chemicals, deep tillage, integrated practices needed. Seed long-lived forcing long-term control.

Category Scores:

22 Geographic score (Add scores 1-4)	**21** Biological Score (Add lines 5-9)
18 Impact Score (Add lines 10-12)	**08** Control Score (Add Lines 13-14)

69 Total Score (Add scores 1-14 and list on front of form)

Risk Category: 55-89+ = **A** 24-54 = **B** < 24 = unlisted.

This Risk Assessment was modified by ODA from the USDA-APHIS Risk Assessment for the introduction of new plant species.
1/15/2013 v.3.8

Oregon Department of Agriculture
Noxious Weed Rating System

Common Name: Wooly distaff thistle, smooth distaff thistle
Scientific Name: *Carthamus lanatus, C. baeticus*

Point Total: 18 **Rating: A**

1) 4 **Detrimental Effects:** Circle all that apply, enter number of circles.
1. *Health*: causes poisoning or injury to humans or animals
2. *Competition:* strongly competitive with crops, forage, or native flora
3. *Host*: host of pathogens and/or pests of crops or forage
4. *Contamination*: causes economic loss as a contaminate in seeds and/or feeds
5. *Interference*: interferes with recreation, transportation, harvest, land value, or wildlife and livestock movement

2) 4 **Reproduction & Capacity for Spread:** Circle the number that best describes, enter that number.
1. Few seeds, not wind blown, spreads slowly
2. Many seeds, slow spread
3. Many seeds, spreads quickly by vehicles or animals
4. Windblown seed, or spreading rhizomes, or water borne
5. Many wind-blown seeds, high seed longevity, spreading rhizomes, perennials

3) 3 **Difficulty to Control:** Circle the number that best describes, enter that number.
1. Easily controlled with tillage or by competitive plants
2. Requires moderate control, tillage, competition or herbicides
3. Herbicides generally required, or intensive management practices
4. Intensive management generally gives marginal control
5. No management works well, spreading out of control

4) 5 **Distribution:** Circle the number that best describes, enter that number.
1. Widely distributed throughout the state in susceptible habitat
2. Regionally abundant, 5 or more counties, more than 1/2 of a county
3. Abundant throughout 1- 4 counties, or 1/4 of a county, or several watersheds
4. Contained in only 1 watershed, or less than 5 square miles gross infestation
5. Isolated infestation less than 640 acres, more than 10 acres
6. Occurs in less than 10 acres, or not present, but imminent from adjacent state

5) 2 **Ecological Impact:** Circle the number that best describes, enter that number.
1. Occurs in most disturbed habitats with little competition
2. Occurs in disturbed habitats with competition
3. Invades undisturbed habitats and crowds out native species
4. Invades restricted habitats (i.e. riparian) and crowds out native species

18 TOTAL POINTS

Note: Noxious weeds are non-native plants with scores of 11 points or higher. Any plants in 4.1, 4.2, and 4.3 should not be classified as "A" rated weeds. *Ratings:* 16 + = A, 15 – 11= B
ODA Weed Rating System 8/30/2012 v.3.2

RA produced by Ken French, ODA. Edited by Glenn Miller, Carri Pirosko ODA

References:

Abrams, L. and Ferris, R. S. 1961. Illustrated flora of the Pacific states. Stanford: Stanford University Press. Briese, D. T. 1988. Weed status of twelve thistle species in New South Wales. Plant Protection Quarterly 3:135-141

Burrill, L. C. 1992. Distaff thistle, *Carthamus lanatus*. Pacific Northwest Extension Bulletin 420. Washington State University Extension.

Burrill, L.C. 1994. Distaff thistle (*Carthamus lanatus*), A "Weeds" Pacific Northwest Extension Publication. PNW 420, reprinted May 1994.

Dellow, J. J., Woodburn-TL, Briese DT, and Corey, S. 1996. Herbicide techniques for thistle management. Plant Protection Quarterly 11 (supplement 2): 276-277.

DiTomaso, J. M. (2004). 2004 Cal-IPC Red Alert! New invasions, recent expansions, and a few others to be on the lookout for. California Invasive Plant Council Symposium 2004. Ventura, CA.

DiTomaso, J. M. and E. A. Healy. 2006. Weeds of California and Other Western States. University of California Department of Agriculture and Natural Resources.

Estilai, A. and Knowles, P. F. 1978. Relationship of Carthamus leucocaulos to other Carthamus species (Compositae). Canadian Journal of Genetics and Cytology 20:221-233.

Forcella, F. and Wood, H. 1986. Sequential flowering of thistles (Cynareae, Asteraceae) in southern Australia. Australian Journal of Botany 34:455-461.

Fromm, G. M. 1990. Chemical control of saffron thistle (Carthamus lanatus L.) in pasture in the South Australian Mallee. Plant Protection Quarterly 5:14-17.

Grace, B. S. et. al. 2002. Seedbanks and seedling emergence of saffron thistle (Carthamus lanatus) in eastern Australian pastures. Australian Journal of Agricultural Research 53 (12), pp. 1327-1334.

Groves, R. H. and Kaye, P. E. 1989. Germination and phenology of seven introduced thistle species in southern Australia. Australian Journal of Botany 37:351-359.

Groves, R. H., Burdon, J.J., Woodburn, T.L., Briese, D.T., and Corey, S. 1996. The use of pathogens native to Europe to control thistles in southern Australia. Plant Protection Quarterly 11 (supplement 2): 256-258.

Hanelt, P. 1976. Carthamus. Flora Europaea. Cambridge, U.K.: Cambridge University Press.

Hickman, J.C. 1993. The Jepson Manual. Higher Plants of California. Berkeley, CA: University of California Press. Munz, P.A. 1968. A California flora and supplement. Berkeley: University of California Press.

Oregon Department of Agriculture, Plant Division, Weed Program. 2010. Personal Communication with staff members: Ken French and Eric Coombs, Natural Resource and Biological Control Specialists, respectively.

Peachey, E., D. Ball, A. Hulting, T. Miller, and D. Morish. The Pacific Northwest Control Handbook. A Pacific Northwest Extension Publication. Weed Control in Range and Pastureland Section Revised December 14, 2009 by T. Miller.

Peirce, J.R. 1990. Morphological and phenological variation in three populations of saffron thistle (Carthamus lanatus) from Western Australia. Australian Journal of Agricultural Research 41:1193-1201.

Quinlivin, B.J. and Pierce, J.R. 1968. The long-term field germination of saffron thistle (Carthamus lanatus L.) and life span of dormant seeds in the Geraldton region, W.A.J. Aust.Inst.Agric.Sci. 34:231-232.

Robbins, W. W., Bellue, M. K., and Ball, W. S. 1951. Weeds of California. Sacramento: CDFA

Sehgal D. et. al. 2009. Nuclear DNA assay in solving issues related to ancestry of the domesticated diploid safflower (Carthamus tinctorius) and the polyploid (Carthamus) taxa, and phylogenetic and genomic relationships in the genus Carthamus (Asteraceae). Molecular Phylogenetics and Evolution 53 (3), pp. 631-644.

Sindel, B. M. 1991. A review of the ecology and control of thistles in Australia. Weed Research 31:189-201.

Whitson, T. D., Burrill, L. C., Dewey, S. A., Cudney, D. W., Nelson, B. E., Lee, R. D., and Parker, R. 1992. Weeds of the West. Jackson, WY: Western Society of Weed Science.

Wright, G. C., McWilliam, J. R., and Whalley, R. D. 1980. Effects of light and leaching on germination of saffron thistle (Carthamus lanatus L.). Aust.J.Plant Physiol. 7:587-594.

www.informedfarmers.com Website refers to oils in seed making them attractive to birds.

Attachment A