

Key Words: High Risk, Naturalized, Minor Weed, Spiny herb, Commercial Crop

Family: Asteraceae

Taxon: *Carthamus tinctorius*

Synonym: *Cathamus tinctorius* L.

Common Name: Safflower
Dyer's saffron
False saffron

Questionnaire :	current 20090513	Assessor:	Chuck Chimera	Designation:	H(HPWRA)
Status:	Assessor Approved	Data Entry Person:	Chuck Chimera	WRA Score	8
101	Is the species highly domesticated?		y=-3, n=0		y
102	Has the species become naturalized where grown?		y=1, n=-1		y
103	Does the species have weedy races?		y=1, n=-1		y
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"		(0-low; 1-intermediate; 2-high) (See Appendix 2)		High
202	Quality of climate match data		(0-low; 1-intermediate; 2-high) (See Appendix 2)		Low
203	Broad climate suitability (environmental versatility)		y=1, n=0		y
204	Native or naturalized in regions with tropical or subtropical climates		y=1, n=0		
205	Does the species have a history of repeated introductions outside its natural range?		y=-2, ?=-1, n=0		y
301	Naturalized beyond native range		y = 1*multiplier (see Appendix 2), n= question 205		y
302	Garden/amenity/disturbance weed		n=0, y = 1*multiplier (see Appendix 2)		y
303	Agricultural/forestry/horticultural weed		n=0, y = 2*multiplier (see Appendix 2)		
304	Environmental weed		n=0, y = 2*multiplier (see Appendix 2)		
305	Congeneric weed		n=0, y = 1*multiplier (see Appendix 2)		y
401	Produces spines, thorns or burrs		y=1, n=0		y
402	Allelopathic		y=1, n=0		
403	Parasitic		y=1, n=0		n
404	Unpalatable to grazing animals		y=1, n=-1		n
405	Toxic to animals		y=1, n=0		
406	Host for recognized pests and pathogens		y=1, n=0		y
407	Causes allergies or is otherwise toxic to humans		y=1, n=0		n
408	Creates a fire hazard in natural ecosystems		y=1, n=0		n
409	Is a shade tolerant plant at some stage of its life cycle		y=1, n=0		n
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)		y=1, n=0		

411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets	y=1, n=0	
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally	y=1, n=-1	y
604	Self-compatible or apomictic	y=1, n=-1	
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	n
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	1
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	y
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	
704	Propagules adapted to wind dispersal	y=1, n=-1	
705	Propagules water dispersed	y=1, n=-1	n
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	y
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m2)	y=1, n=-1	
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	y=-1, n=1	

Designation: H(HPWRA)

WRA Score **8**

Supporting Data:

101	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Is the species highly domesticated?? Yes] "Many cvs have been developed differing in flower color, degree of spininess, head size, oil content, resistance to disease and ease of harvest. Most common varieties have yellow or orange flowers, but red and white flowered varieties are known. Among the best cvs are: 'Gila' - a high yielding, high test-weight variety, adapted to Arizona growing conditions; 'Frio' - a highly cold tolerant variety with oil and protein content higher than 'Gila', 'Ute' - yield and oil percentage about equal to 'Gila', but highly susceptible to disease and lodging; 'US 10' - similar content, resistant to Phytophthora root rot. Many other cvs have seed with lower hull percentage and higher oil and protein content. Commercial cvs grown in the United States are spiny; present spineless cvs contain too little oil. 'Dart' has tolerance for Phytophthora, Puccinia and Verticillium. It is cold tolerant during early growth. In a 5-year period of testing at Mesa, 'Dart' averaged 4,004 kg/ha. In India, the new non-spiny safflower cv, 'CO 1' averaged yields of 1,020 kgha with irrigation, 720 kg rainfed compared to 790 and 630 kg respectively with the standard cv 'K-1' seed oil contents were 32.1% in 'CO 1', 30.3 in 'K-1'. 'CO-1' tolerates <i>Alternaria carthami</i> infection and is moderately resistant to wilt, while 'K-1' is susceptible to them (Subramanian et al, 1979). Reported from the Central Asian and Near Eastern Center of Diversity, safflower or cvs thereof is reported to tolerate bacteria, disease, drought, frost, fungus, high pH, phage, salt, sand, rust, virus, wind, and wild. Wu and Jain (1977) discuss germplasm diversity in the World Collections of Safflower. (2n = 24, 32)."
101	2004. McPherson, M.A./Good, A.G./Topinka, A.K.C./Hall, L.M.. Theoretical hybridization potential of transgenic safflower (<i>Carthamus tinctorius</i> L.) with weedy relatives in the New World. <i>Canadian Journal of Plant Science</i> . 84(3): 923-934.	[Is the species highly domesticated?? Yes] "Safflower is thought to have originated in the Euphrates basin (Knowles 1969, 1989) and from this center of origin, cultivation expanded to Egypt, Ethiopia, southern Europe, southern Asia and the Far East (Smith 1996). Hybridization with several wild species of <i>Carthamus</i> may have played a major role in the evolution of <i>C. tinctorius</i> in the Mediterranean and Asia where they are sympatric (Ashri and Knowles 1960; Schank and Knowles 1964). Cultivation of safflower in the New World began in 1899, and it was commercially grown in the 1950s (Knowles 1958, 1989)."
101	2011. Mayerhofer, M./Mayerhofer, R./Topinka, D./Christianson, J./Good, A.G .. Introgression potential of transgenic safflower (<i>Carthamus tinctorius</i>) and wild relatives of the genus <i>Carthamus</i> . <i>BMC Plant Biology</i> . 11: doi:10.1186/1471-2229-11-47.	[Is the species highly domesticated? Yes] "Safflower is considered one of humanities' oldest crops and has therefore been selected for domestication traits over several centuries [25]. It does have numerous wild relatives and gene transfer through interspecific hybridization may introduce weedy traits into the commercial crop, creating the potential for invasive hybrid populations [26-28]."
102	2004. McPherson, M.A./Good, A.G./Topinka, A.K.C./Hall, L.M.. Theoretical hybridization potential of transgenic safflower (<i>Carthamus tinctorius</i> L.) with weedy relatives in the New World. <i>Canadian Journal of Plant Science</i> . 84(3): 923-934.	[Has the species become naturalized where grown? Yes] "Weedy and wild relatives of <i>C. tinctorius</i> were naturalized in the New World as early as 1891 (Fuller 1979)."
103	2004. McPherson, M.A./Good, A.G./Topinka, A.K.C./Hall, L.M.. Theoretical hybridization potential of transgenic safflower (<i>Carthamus tinctorius</i> L.) with weedy relatives in the New World. <i>Canadian Journal of Plant Science</i> . 84(3): 923-934.	[Does the species have weedy races? Yes] "Weedy and wild relatives of <i>C. tinctorius</i> were naturalized in the New World as early as 1891 (Fuller 1979)."
201	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Species suited to tropical or subtropical climate(s) 0-Low] "Believed to have originated in southern Asia and is known to have been cultivated in China, India, Persia and Egypt almost from prehistoric times. During Middle Ages it was cultivated in Italy, France, and Spain, and soon after discovery of America, the Spanish took it to Mexico and then to Venezuela and Colombia. It was introduced into United States in 1925 from the Mediterranean region and is now grown in all parts west of 100th meridian. " ... "Safflower grows in the temperate zone in areas where wheat and barley do well, and grows slowly during periods of cool short days in early part of season."
202	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Quality of climate match data 0-Low]

203	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Broad climate suitability (environmental versatility)? Yes] "Ranging from Cool Temperate Steppe to Moist through Tropical Desert to Tropical Dry Forest Life Zones, safflower is reported to tolerate annual precipitation of 2.0 to 13.7 dm (mean of 38 cases = 6.9), annual temperature of 6.3 to 27.5deg.C (mean of 38 cases 17.5), and pH of 5.4 to 8.2 (-9.0) (mean of 33 cases = 7.1) (Duke, 1978, 1979)."
205	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Does the species have a history of repeated introductions outside its natural range? Yes] "Believed to have originated in southern Asia and is known to have been cultivated in China, India, Persia and Egypt almost from prehistoric times. During Middle Ages it was cultivated in Italy, France, and Spain, and soon after discovery of America, the Spanish took it to Mexico and then to Venezuela and Colombia. It was introduced into United States in 1925 from the Mediterranean region and is now grown in all parts west of 100th meridian."
301	1987. Garnock-Jones, P.J.. Checklist of dicotyledons naturalised in New Zealand 19. Asteraceae (Compositae) subfamily Cichorioideae,. New Zealand Journal of Botany,. 25(4): 503-510.	[Naturalized beyond native range? Yes] "Seventy-one taxa of Asteraceae subfamily Cichorioideae (4 Arctoteae, 29 Cardueae, 1 Echinopeae, 36 Lactuceae, and 1 Vernonieae) are recorded as naturalised in New Zealand." ... " <i>Carthamus tinctorius</i> L. safflower Distribution: near Blenheim."
301	2006. Howell, C.J./Sawyer, J.W.D.. New Zealand naturalised vascular plant checklist. New Zealand Plant Conservation Network, Wellington, NZ www.nzpcn.org.nz	[Naturalized beyond native range? Possibly Yes] " <i>Carthamus tinctorius</i> " ... "Casual"
301	2012. Calflora. The Calflora Database - <i>Carthamus tinctorius</i> . http://www.calflora.org/cgi-bin/species_query.cgi?where-taxon=Carthamus+tinctorius	[Naturalized beyond native range? Yes] " <i>Carthamus tinctorius</i> , a dicot, is an annual herb that is not native to California; it was introduced from elsewhere and naturalized in the wild."
302	2006. WWF Australia. National list of naturalised invasive and potentially invasive garden plants. http://www.wwf.org.au/publications/ListInvasivePlants/	[Garden/amenity/disturbance weed? Yes] " <i>Carthamus tinctorius</i> " ... "Australian Rating = 3" [3 = Naturalised and known to be a minor problem warranting control at 4 or more locations within a State or Territory. A weed of minor but unspecified impacts]
303	2006. Martin, T.G./Campbell, S./Grounds, S.. Weeds of Australian rangelands. The Rangeland Journal. 28: 3-26.	[Agricultural/forestry/horticultural weed? No evidence] "Appendix 1. List of 622 non-native plant species that occur in the rangelands, including 153 species, representing 94 taxa (Table 2), which pose a threat to rangeland biodiversity. Species known to have an impact on rangeland biodiversity are noted (Y)." [<i>Carthamus tinctorius</i> included in list of plants, but not noted to have an impact on biodiversity]
304	2007. Randall, R.P.. Global Compendium of Weeds - <i>Carthamus tinctorius</i> [Online Database]. http://www.hear.org/gcw/species/carthamus_tinctorius/	[Environmental weed? Possibly] Evidence of environmental impacts not found in subsequent literature searches.
305	1996. Li, D./Mündel, H.-H.. Safflower, <i>Carthamus Tinctorius</i> L. Volume 7 of Promoting the conservation and use of underutilized and neglected crops. Bioversity International,	[Congeneric weed? Yes] "The weedy progenitors of cultivated safflower are widely distributed in the areas where safflower is grown. <i>Carthamus oxyacanthus</i> is a very serious common weed of Pakistan and northwest India, west to Iraq, adapted to habitats associated with people and crop cultivation (Ashri and Knowles 1960), common in disturbed soils along roadsides and growing after crops such as wheat and barley are harvested. It is a branching, very spiny, annual weed."
305	2002. Grace, B.S./Whalley, R.D.B./Sheppard, A.W./Sindel, B.M.. Managing saffron thistle in pastures with strategic grazing. The Rangeland Journal. 24: 313-325.	[Congeneric weed? Yes] "Saffron thistle (<i>Carthamus lanatus</i> L.) is a native of the Mediterranean region and is now widespread in Australia (Parsons and Cuthbertson 1992). It is arguably the most economically damaging thistle species in New South Wales (Briese 1988), and is common in 500 to 875 mm rainfall areas (Bowman et al. 1999)."
401	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Produces spines, thorns or burrs? Yes] "Annual thistle-like herb, coarse, branching above with a strong central stem to 1.5 m tall; leaves spiny, oblong or ovate-lanceolate, waxy, the upper ones clasping, minutely spinose-toothed; flowers in 1-5 heads per plant, 2.5-3.7 cm across, each head developing 15-50 seeds; corollas yellow, orange, white or red, surrounded by a cluster of leafy spiny bracts, which pass over gradually into the bracts of the involucre"
401	2007. Singh, V./Nimbkar, N.. Safflower (<i>Carthamus tinctorius</i> L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Produces spines, thorns or burrs? Yes] "Safflower in general is a spiny crop. However, the entire production of safflower in China is under spineless cultivars. Safflower production world over, barring China, is under spiny cultivars."

402	2007. Machado, S.. Allelopathic Potential of Various Plant Species on Downy Brome: Implications for Weed Control in Wheat Production. <i>Agronomy Journal</i> . 99: 127–132.	[Allelopathic? Potentially] "Of the plant species evaluated, shoot extracts, comprising mostly of leaves, were more effective in reducing seed germination and root and shoot length of downy brome than root extracts." ... "However some plants, such as winged bean, lab lab rongai, tepary bean, grain sorghum, and sunflower (<i>Carthamus tinctorius</i> L.), showed more phytotoxic effects in root than in shoot extracts. Differences in shoot and root extract effects may indicate the presence of different allelochemicals or concentrations of allelochemicals in roots and shoots."
403	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Parasitic? No] "Annual thistle-like herb, coarse, branching above with a strong central stem to 1.5 m tall"
404	2007. Landau, S./Molle, G./Fois, N. et al.. Safflower (<i>Carthamus tinctorius</i> L.) as a novel pasture species for dairy sheep in the Mediterranean conditions of Sardinia and Israel. <i>Small Ruminant Research</i> . 59: 239-249.	[Unpalatable to grazing animals? No] "Safflower hay, given ad libitum, was successfully used as sole food for late-pregnant dairy cows (Landau et al., 2004) and was reported to improve fertility in Canadian ewes, when compared with alfalfa-grass hay (Stanford et al., 2001). Safflower cropped at the budding stage can be ensiled (Weinberg et al., 2002), and safflower silage substituted for cereal silage in the diet of high-yielding dairy cows without affecting dairy performance (Landau et al., 2004). Grazed safflower was shown to sustain satisfactory growth rates in Australian steers (French et al., 1988). The in vivo digestibility and the intake of green safflower fodder in confined sheep were similar to those of a vetch–oats mixture (Vonghia et al., 1992)." ... "Safflower, cultivated under Mediterranean conditions, can serve as high-quality pasture for sheep. It exhibits vigorous growth in spring and can support adequate growth in hoggets and milk yield in dairy ewes until its nutritional value declines close to blooming. Sown pastures of safflower enable to lengthen the period of grazing in lush green pasture in the arid parts of the Mediterranean basin (250mm of rainfall), but not under milder, semi-arid Mediterranean climates (590mm of rainfall)."
405	2007. Landau, S./Molle, G./Fois, N. et al.. Safflower (<i>Carthamus tinctorius</i> L.) as a novel pasture species for dairy sheep in the Mediterranean conditions of Sardinia and Israel. <i>Small Ruminant Research</i> . 59: 239-249.	[Toxic to animals? No evidence] "Safflower hay, given ad libitum, was successfully used as sole food for late pregnant dairy cows (Landau et al., 2004) and was reported to improve fertility in Canadian ewes, when compared with alfalfa-grass hay (Stanford et al., 2001). Safflower cropped at the budding stage can be ensiled (Weinberg et al., 2002), and safflower silage substituted for cereal silage in the diet of high-yielding dairy cows without affecting dairy performance (Landau et al., 2004). Grazed safflower was shown to sustain satisfactory growth rates in Australian steers (French et al., 1988). The in vivo digestibility and the intake of green safflower fodder in confined sheep were similar to those of a vetch–oats mixture (Vonghia et al., 1992)."
405	2011. eHow. Is <i>Carthamus Tinctorius</i> Safe for Dogs to Lick?. http://www.ehow.com/info_12116220_carthamus-tinctorius-safe-dogs-lick.html	[Toxic to animals? Possibly to dogs] "If you see <i>Carthamus tinctorius</i> , keep your dog away from it. Though this plant is not on the ASPCA's list of plants toxic to dogs and is in fact used as animal feed, it can still harm your dog if your dog is allowed to lick it. Like all plants with spines, the spines on <i>Carthamus tinctorius</i> could hurt your dog's tongue, nose or eyes. Also, <i>Carthamus tinctorius</i> can act as a laxative in large quantities, so it could give your dog digestive problems."
406	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Host for recognized pests and pathogens? Yes] "Safflower is attacked by many fungi: <i>Alternaria carthami</i> (leaf spot and bud rot), <i>A. zinniae</i> , <i>Bremia lactucae</i> , <i>Cercospora carthami</i> , <i>Cercospora carthami</i> , <i>Chaetomium globosum</i> , <i>collectorichum capsici</i> , <i>Corticium solani</i> , <i>Ectocroma carthami</i> , <i>Epicoccum nigrum</i> , <i>Erysiphe cichoracearum</i> , <i>Fusarium acuminatum</i> , <i>F. solani</i> , <i>Gloeosporium carthami</i> , <i>Glomerella cingulata</i> , <i>Leveillula compositarum</i> , <i>L. taurica</i> , <i>Macrophomina phaseoli</i> , <i>Macrosporium carthami</i> , <i>Marsonia carthami</i> , <i>Oidium carthami</i> , <i>Oidiopsis taurica</i> , <i>Phyllosticta carthami</i> , <i>Phytophthora drechsleri</i> (root rot), <i>Ph. palmivora</i> , <i>Ph. parasitica</i> , <i>Puccinia carthami</i> (rust), <i>Pythium debaryanum</i> , <i>P. oligandrum</i> , <i>Ramularia carthami</i> , <i>Sclerotinia sclerotiorum</i> , <i>Septoria carthami</i> , <i>Verticillium albo-atrum</i> (wilt). It is parasitized by <i>Orobanche cernua</i> and <i>Striga lutea</i> , and is attacked by the Chili mosaic and Cucumber mosaic viruses. <i>Pseudomonas solanacearum</i> , a bacterium, attacks it. Among the nematodes, the following have been isolated from safflower: <i>M. Meliodogyne incognita acrita</i> , <i>M. javanica</i> , (Golden p.c., 1984). Insect pests include: <i>Lygus</i> bugs, wireworms, aphids, leaf hoppers, thrips, and sunflower moth larvae."

406	2007. Singh, V./Nimbkar, N.. Safflower (<i>Carthamus tinctorius</i> L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Host for recognized pests and pathogens? Yes] "Safflower is attacked by many diseases caused by fungi, bacteria, viruses, or physiological disorders due to abiotic stresses. Patil et al. (1993) reported that safflower is recorded to be infested around the world by 57 pathogens, including 40 fungi, 2 bacteria, 14 viruses, and 1 mycoplasma. Of these, <i>Alternaria</i> leaf spot caused by <i>Alternaria carthami</i> and wilt caused by <i>Fusarium oxysporum</i> are the most devastating ones and can cause 13 to 49% losses and wipe out the entire crop in the region under conditions conducive to their development, as indicated above in the case of India. Breeding safflower for disease resistance is the most economical and convenient method for controlling major diseases in safflower."
407	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Causes allergies or is otherwise toxic to humans? No evidence]
407	2007. Singh, V./Nimbkar, N.. Safflower (<i>Carthamus tinctorius</i> L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Causes allergies or is otherwise toxic to humans? No evidence] "Safflower oil meal is mainly used as animal feed. Safflower cake has the potential to be used as a human food if the bitter principles are removed (Nagaraj, 1995). Safflower cake in combination with all-purpose flour in 1:3 proportion was found to be highly suitable for manufacturing of protein-enriched biscuits with 22% protein in them (Singh and Abidi, 2005). Safflower leaves are rich in carotene, riboflavin, and vitamin C, and hence young seedlings and prunings are used as a green leafy vegetable in safflower-growing areas in India."
408	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Creates a fire hazard in natural ecosystems? No evidence from cultivation]
408	2007. Singh, V./Nimbkar, N.. Safflower (<i>Carthamus tinctorius</i> L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Creates a fire hazard in natural ecosystems? No evidence from cultivation]
409	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Is a shade tolerant plant at some stage of its life cycle? No] "It is shade and weed intolerant, will not grow as a weed because other wild plants overshadow it before it becomes established."
410	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Tolerates a wide range of soil conditions ? Possibly] " It thrives in heavy clays with good waterholding capacity, but will grow satisfactorily in deep sandy or clay loams with good drainage, and needs soil moisture from planting through flowering. Soils approaching neutral pH are best."
411	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Climbing or smothering growth habit? No] "Annual thistle-like herb, coarse, branching above with a strong central stem to 1.5 m tall"
412	2007. Singh, V./Nimbkar, N.. Safflower (<i>Carthamus tinctorius</i> L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Forms dense thickets? Unknown] No evidence
501	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Aquatic? No] "Annual thistle-like herb..." [Terrestrial]
502	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Grass? No] Asteraceae
503	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Nitrogen fixing woody plant? No] Asteraceae

504	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)? No] "Annual thistle-like herb, coarse, branching above with a strong central stem to 1.5 m tall; leaves spiny, oblong or ovate-lanceolate, waxy, the upper ones clasping, minutely spinose-toothed; flowers in 1-5 heads per plant" ... "Sturdy taproot penetrating to 2.5 m. " [But not a geophyte]
601	2007. Singh, V./Nimbkar, N.. Safflower (<i>Carthamus tinctorius</i> L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Evidence of substantial reproductive failure in native habitat? No] No evidence, although region of origin uncertain
602	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Produces viable seed? Yes] "Propagation is by seed, which are usually pretreated with insecticides and fungicides."
603	2004. McPherson, M.A./Good, A.G./Topinka, A.K.C./Hall, L.M.. Theoretical hybridization potential of transgenic safflower (<i>Carthamus tinctorius</i> L.) with weedy relatives in the New World. Canadian Journal of Plant Science. 84(3): 923-934.	[Hybridizes naturally? Yes] "Hybridization with <i>C. tinctorius</i> and several wild relatives has been demonstrated to occur artificially (hand pollination; Kadam and Patankar 1942; Claassen 1950; Ashri and Knowles 1960; Ashri and Efron 1964; Imrie and Knowles 1970; Khidir and Knowles 1970a, b; Estilai and Knowles 1976, 1978; Estilai 1977; Heaton and Klisiewicz 1981) and naturally (open pollination; Kadam and Patankar 1942; Claassen 1950; Ashri and Rudich 1965)." ... "Although <i>Carthamus tinctorius</i> has been cultivated for more than 1000 yr (Knowles and Ashri 1995; Smith 1996), interspecific hybridization experiments have shown that <i>C. tinctorius</i> can be crossed with several wild relatives to produce fertile progeny"
603	2011. Mayerhofer, M./Mayerhofer, R./Topinka, D./Christianson, J./Good, A.G .. Introgression potential between safflower (<i>Carthamus tinctorius</i>) and wild relatives of the genus <i>Carthamus</i> . BMC Plant Biology. 11: doi:10.1186/1471-2229-11-47.	[Hybridizes naturally? Yes] "In this study, we report that commercial safflower will cross readily with different members of the same section (<i>Carthamus</i>) and several species with different chromosome numbers. All of these crosses produce F1 plants and most of them, particularly coming from wild relatives with n = 10 and n = 12, are viable and fertile. However, there is no evidence of hybrid vigour or other benefits provided to them."
604	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Self-compatible or apomictic? Potentially Yes] "Safflower is self-pollinated with some cross pollination."
604	2007. Singh, V./Nimbkar, N.. Safflower (<i>Carthamus tinctorius</i> L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Self-compatible or apomictic? Possibly apomictic] "Apomixis is yet to be confirmed in safflower, though preliminary studies carried out at the Nimbkar Agricultural Research Institute (NARI) at Phaltan in India indicate the possibility of existence of apomixis in safflower. Cytological and breeding investigations are under way at NARI to confirm the presence of apomixis in safflower."
604	2011. Abrol, D.P.. Pollination Biology: Biodiversity Conservation and Agricultural Production. Springer, New York	[Self-compatible or apomictic? Potentially] "Honeybee pollination not only helps seed production in self-sterile varieties, but also enhances yield and quality in self-fertile varieties." [Both self-sterile and self-fertile varieties exist]
605	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Requires specialist pollinators? No] "flowers in 1-5 heads per plant, 2.5-3.7 cm across, each head developing 15-50 seeds; corollas yellow, orange, white or red, surrounded by a cluster of leafy spiny bracts, which pass over gradually into the bracts of the involucre" ... "Pollen and nectaries are abundant with insect working the flowers."
605	2007. Singh, V./Nimbkar, N.. Safflower (<i>Carthamus tinctorius</i> L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Requires specialist pollinators? No] "Safflower pollen is transferred by insects and not by wind. The most prevalent pollinator agent in safflower is honey bees. Bees visit the safflower flowers for both pollen and nectar. Each safflower capitulum produces 15 to 60 seeds."
606	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Reproduction by vegetative fragmentation? No] "Annual thistle-like herb, coarse, branching above with a strong central stem to 1.5 m tall" ... "Propagation is by seed, which are usually pretreated with insecticides and fungicides."
607	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Minimum generative time (years)? 1] "Annual thistle-like herb, coarse, branching above with a strong central stem to 1.5 m tall" ... "Safflower matures in from 110-150 days from planting to harvest as a spring crop, as most of it is grown, and from 200 or more days as fall crop." [Annual. Completed life cycle in one growing season]

701	1999. Rozeffelds, A.C.F./Cave, L./Morris, D.I./Buchanan, A.M.. The Weed Invasion in Tasmania since 1970. Australian Journal of Botany. 47: 23-48.	[Propagules likely to be dispersed unintentionally? Yes] "Carthamus tinctorius has been noted as coming from parrot cage cleanings as has one collection of Guizotia abyssinica."
701	2009. Nesom, G.. Notes on Non-native Asteraceae in Texas. Phytologia. 91(2): 325-332.	[Propagules likely to be dispersed unintentionally ? Yes] "Carthamus tinctorius L." ... "weed in yard, probably from bird seed, 19 Jun 1996, Sylvester 2414 (BRIT)."
702	2007. Singh, V./Nimbkar, N.. Safflower (Carthamus tinctorius L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Propagules dispersed intentionally by people? Yes] "Traditionally, safflower has been grown for centuries from China to the Mediterranean region and all along the Nile valley up to Ethiopia (Weiss, 1971). Presently it is grown commercially in India, the U.S., Mexico, Ethiopia, Kazakhstan, Australia, Argentina, Uzbekistan, China, and the Russian Federation. Pakistan, Spain, Turkey, Canada, Iran, and Israel also grow safflower to a limited extent."
703	1999. Rozeffelds, A.C.F./Cave, L./Morris, D.I./Buchanan, A.M.. The Weed Invasion in Tasmania since 1970. Australian Journal of Botany. 47: 23-48.	[Propagules likely to disperse as a produce contaminant? Possibly] "Carthamus tinctorius has been noted as coming from parrot cage cleanings as has one collection of Guizotia abyssinica."
703	2012. WRA Specialist. Personal Communication.	[Propagules likely to disperse as a produce contaminant? Potentially] If cultivated on a large commercial scale, seeds could potentially contaminate other crops
704	2007. Singh, V./Nimbkar, N.. Safflower (Carthamus tinctorius L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Propagules adapted to wind dispersal? Possibly Yes] "It produces white, shiny, and smooth seeds (fruits) called achenes, each weighing from 0.01 to 0.1 g. They may be with or without pappus (tufts of hair present on the seed) and are four sided, having thick pericarp." [Achenes with pappus are adapted for wind dispersal]
704	2011. Mayerhofer, M./Mayerhofer, R./Topinka, D./Christianson, J./Good, A.G .. Introgression potential between safflower (Carthamus tinctorius) and wild relatives of the genus Carthamus. BMC Plant Biology. 11: doi:10.1186/1471-2229-11-47.	[Propagules adapted to wind dispersal? Possibly] "Another trait that alters seed dispersal in the Asteraceae is the presence of a pappus, a seed appendage for dispersal via water, wind and adherence to animal fur. Most of the seeds of safflower lack a pappus and when it is present, it is less than the length of the achenes. The gene controlling the presence of a pappus in C. persicus has been shown to be dominant (P ₋), while commercial safflower is homozygous recessive for this locus (pp) [30]."
705	2007. Singh, V./Nimbkar, N.. Safflower (Carthamus tinctorius L.) P. 167-194. In Singh, R.J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement. Volume 4 : Oilseed Crops. CRC Press, Taylor & Francis Group, Boca Raton, FL	[Propagules water dispersed? No] "It produces white, shiny, and smooth seeds (fruits) called achenes, each weighing from 0.01 to 0.1 g. They may be with or without pappus (tufts of hair present on the seed) and are four sided, having thick pericarp." [Seeds may be moved by water, but primary dispersal vector is wind or gravity]
706	2008. Cummings, J.L./Handley, L.W./Macbryde, B./Tupper, S.K./Werner, S.J./Byram, Z.J.. Dispersal of viable row-crop seeds of commercial agriculture by farmland birds: implication for genetically modified crops. Environmental Biosafety Research. 7: 241-252	[Propagules bird dispersed? No] "Captive mallards, pheasants, blackbirds and pigeons that fed freely for 2 h each day on commercial seeds of maize, barley, safflower and rice did not pass any of these seeds intact through the digestive tract" ... "Viable commercial agriculture seeds from maize, barley, safflower and rice crops can be dispersed by farmland birds, but the potential and the frequency are low. Primary dispersal via the digestive tract is very unlikely."
707	2008. Cummings, J.L./Handley, L.W./Macbryde, B./Tupper, S.K./Werner, S.J./Byram, Z.J.. Dispersal of viable row-crop seeds of commercial agriculture by farmland birds: implication for genetically modified crops. Environmental Biosafety Research. 7: 241-252	[Propagules dispersed by other animals (externally)? Yes] "Only pheasants and pigeons transported seeds on their feet and legs. Pheasants transported the most seeds: an average of 0.9 ± 0.4 maize, 6.3 ± 1.3 barley, 10.1 ± 3.5 safflower and 13.1 ± 3.4 rice seeds. Pheasants also had the greatest amount of soil attached to their feet and legs..." ... "Many commercial agriculture seeds, including maize, rice and safflower, have relatively smooth seeds and thus do not attach easily to bird feathers or other body parts. In our study, no seeds were found on feathers, and there were only four instances of seeds (of barley, safflower and rice) found attached to the muddy feet or legs of birds (pheasants and pigeons)"
708	2008. Cummings, J.L./Handley, L.W./Macbryde, B./Tupper, S.K./Werner, S.J./Byram, Z.J.. Dispersal of viable row-crop seeds of commercial agriculture by farmland birds: implication for genetically modified crops. Environmental Biosafety Research. 7: 241-252	[Propagules survive passage through the gut? Not of birds] "Captive mallards, pheasants, blackbirds and pigeons that fed freely for 2 h each day on commercial seeds of maize, barley, safflower and rice did not pass any of these seeds intact through the digestive tract" ... "Mallards, pheasants, blackbirds and pigeons orally gavaged (force-fed) with seeds of maize, barley, safflower and rice also did not pass any seeds intact through the digestive tract"

801	1983. Duke, J.A.. Handbook of Energy Crops - <i>Carthamus tinctorius</i> . http://www.hort.purdue.edu/newcrop/duke_energy/Carthamus_tinctorius.html	[Prolific seed production (>1000/m ²)? Unknown. Numbers are from cultivation] "Seed weighs from 81 to 105 kg/bu, the weight depending on the variety and the growing conditions. In California average yields are 1,900 kg/ha, but yields above 4,500 kg/ha are not uncommon; in the Great Plains yields run about 850 kg/ha. In Arizona 'Dart' yields 4,004 kg/ha or 1,622 kg oil/ha, 25% more than the open-headed Gila which is susceptible to birds. The cost of growing safflower runs just a little more per ha than barley. This crop is usually grown and sold under contract, either by a fixed price per ton or at market price at harvest. The major producer of safflower is India where 590,000 ha were grown in 1970-71, producing about 300,000 MT. India produced about 48,000 MT oil in 1969-1970 and domestically consumed that plus 4,000 MT imported. In India, when seed oil is the object, yields are about 90-130 kg florets, and 440 to 660 kg seed/ha. Intercropped yields are only 110 to 279 kg/ha seed (C.S.I.R., 1948 1976)."
802	2008. Royal Botanic Gardens Kew. Seed Information Database (SID). Version 7.1. http://data.kew.org/sid/	[Evidence that a persistent propagule bank is formed (>1 yr)? Potentially] "Storage Behaviour: Orthodox Storage Conditions: Seeds maintained for 17 years in hermetic storage at -12°C with 4% mc (Stanwood & Bass, 1981); seeds not damaged from exposure to liquid nitrogen (Stanwood & Bass, 1981); seeds are maintained at PGRC/Ethiopia (Zewdie, 1994); long-term storage under IPGRI preferred conditions at RBG Kew, WP. Oldest collection 18 years; germination change 100 to 100%, 14 years, 1 collection" [Unknown from field settings]
803	1990. Fromm, G.M.. Chemical control of saffron thistle (<i>Carthamus lanatus</i> L.) in pasture in the South Australian Mallee. <i>Plant Protection Quarterly</i> . 5(1): 14-17.	[Well controlled by herbicides? Yes] "Several herbicide treatments were evaluated for the control of, or the reduction in normal seed head development of, saffron thistle (<i>C. lanatus</i>) in pasture in the South Australian Mallee. Paraquat at 100 g/ha applied either alone, or as a proprietary mixture with diquat or amitrole (Pre-Ceed), effectively controlled saffron thistle at the stem elongation stage when the majority of plants were between 12 cm and 50 cm high. Higher rates were needed to obtain acceptable control when applied at the rosette and flowering stages. Glyphosate at 162 g was not as effective as paraquat at 100 g when applied at the rosette or stem elongation stage. Applications to saffron thistle rosettes of paraquat at 400 g applied alone and 375 g applied as a proprietary mixture with diquat, and glyphosate at 324 g gave effective control. When applied to flowering saffron thistle paraquat at 200 g with diquat, and glyphosate at 216 g and 270 g were the most effective treatments in reducing the number of normal seed heads formed. Saffron thistle plants which survived the glyphosate treatments applied at stem elongation or flowering stage developed seed heads in the leaf axils of the main stem and still set some seed." [No information for <i>Carthamus tinctorius</i> , but herbicides that work on <i>C. lanatus</i> would presumably also be effective]
804	2012. WRA Specialist. Personal Communication.	[Tolerates, or benefits from, mutilation, cultivation, or fire? Unknown]
805	2012. WRA Specialist. Personal Communication.	[Effective natural enemies present locally (e.g. introduced biocontrol agents)? Unknown]

Summary of Risk Traits

High Risk / Undesirable Traits

- Widely naturalized
- Controlled as a weed in Australia
- Spiny form most common
- Hybridizes with other *Carthamus* species
- Reached maturity in <1 year (annual life cycle)
- Seeds may be accidentally dispersed

Low Risk / Desirable Traits

- Documented as a weed, but impacts minor or unspecified
- Palatable to grazing animals
- Non-spiny form exists
- Source of food & dye for humans
- Shade-intolerant
- Herbicides would likely provide effective control