

<b>Taxon:</b> <i>Trifolium pratense</i> L.	<b>Family:</b> Fabaceae
<b>Common Name(s):</b> Chilean clover cowgrass clover mammoth red clover medium red clover peavine clover purple clover red clover	<b>Synonym(s):</b> <i>Trifolium pratense</i> L. var. <i>americanum</i> <i>Trifolium pratense</i> L. var. <i>perenne</i> <i>Trifolium pratense</i> L. var. <i>pratense</i> <i>Trifolium pratense</i> L. var. <i>sativum</i> <i>Trifolium pratense</i> L. var. <i>villosum</i> DC.

<b>Assessor:</b> Chuck Chimera	<b>Status:</b> Assessor Approved	<b>End Date:</b> 6 Mar 2019
<b>WRA Score:</b> 13.0	<b>Designation:</b> H(HPWRA)	<b>Rating:</b> High Risk

**Keywords:** Biennial Herb, Widely Naturalized, Fodder, N-Fixing, Animal-Dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
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)	Intermediate
202	Quality of climate match data	(0-low; 1-intermediate; 2-high) (See Appendix 2)	High
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	y
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		
304	Environmental weed		
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals		

Qsn #	Question	Answer Option	Answer
406	Host for recognized pests and pathogens		
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	y
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	y
411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets	y=1, n=0	n
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		
604	Self-compatible or apomictic		
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
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		
704	Propagules adapted to wind dispersal		
705	Propagules water dispersed	y=1, n=-1	y
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	y
801	Prolific seed production (>1000/m <sup>2</sup> )		
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	y
803	Well controlled by herbicides	y=-1, n=1	y
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

**Supporting Data:**

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	Dias, P. M. B., Julier, B., Sampoux, J. P., Barre, P., & Dall’Agnol, M. (2008). Genetic diversity in red clover ( <i>Trifolium pratense</i> L.) revealed by morphological and microsatellite (SSR) markers. <i>Euphytica</i> , 160(2), 189-205	[Cultivars exist. No evidence of high levels of domestication] "Although red clover has a Mediterranean origin, it is a cosmopolitan species adapted to many edaphic– climatic conditions (Taylor and Smith 1979). Like many common plant species, this broad range of adaptation is due to the existence of a high number of local adapted genotypes rather than a single ubiquitous genotype (Joshi et al. 2001; Taylor and Smith 1995). Indeed, Taylor and Smith (1995) showed that most cultivars are not adapted to areas far from where they were developed. A large genetic diversity, with a structuration related to adaptative traits, can thus be anticipated."

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. (2019). Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. (2019). Personal Communication	NA

Qsn #	Question	Answer
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	Intermediate
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. <a href="http://www.ars-grin.gov/npgs/index.html">http://www.ars-grin.gov/npgs/index.html</a> . [Accessed 4 Mar 2019]	"Native Africa NORTHERN AFRICA: Algeria (n.), Morocco, Tunisia Asia-Temperate WESTERN ASIA: Afghanistan, Cyprus, Iran, Iraq, Israel, Jordan, Lebanon, Turkey CAUCASUS: Armenia, Azerbaijan, Georgia, Russian Federation-Ciscaucasia [Ciscaucasia] SIBERIA: Russian Federation-Eastern Siberia, [Eastern Siberia (s.)] Russian Federation-Western Siberia [Western Siberia] MIDDLE ASIA: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan Asia-Tropical INDIAN SUBCONTINENT: India (n.w.), Pakistan (n.) Europe NORTHERN EUROPE: Denmark, Finland, Ireland, Norway, Sweden, United Kingdom MIDDLE EUROPE: Austria, Belgium, Czechoslovakia, Germany, Hungary, Netherlands, Poland, Switzerland EASTERN EUROPE: Belarus, Latvia, Lithuania, Moldova, Ukraine SOUTHEASTERN EUROPE: Albania, Bulgaria, Former Yugoslavia, Greece, Italy (incl. Sardinia, Sicily), Romania SOUTHWESTERN EUROPE: France (incl. Corsica), Portugal, Spain"

202	Quality of climate match data	High
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. <a href="http://www.ars-grin.gov/npgs/index.html">http://www.ars-grin.gov/npgs/index.html</a> . [Accessed 4 Mar 2019]	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i naturalized in wet, open areas such as pastures and lawns, 820- 2,070 m, on Maui and Hawai'i." [Elevation range exceeds 1000 m, demonstrating environmental versatility]
	Duke, J. A. (1983). <i>Trifolium pratense</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html">https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html</a> . [Accessed 4 Mar 2019]	"Ranging from Boreal Moist to Wet through Subtropical Moist Forest Life Zones, red clover is reported to tolerate annual precipitation of 3.1 to 19.2 dm (mean of 91 cases = 8.6 dm), annual mean temperature of 4.9 to 20.3°C (mean of 91 cases = 10.6°C), and pH of 4.5 to 8.2 (mean of 84 cases = 6.3)."

Qsn #	Question	Answer
	Dave's Garden. (2019). <i>Trifolium</i> Species, Red Clover - <i>Trifolium pratense</i> . <a href="https://davesgarden.com/guides/pf/go/31462/">https://davesgarden.com/guides/pf/go/31462/</a> . [Accessed 4 Mar 2019]	[Grows in >5 hardiness zones] "Hardiness: USDA Zone 3a: to -39.9 °C (-40 °F) USDA Zone 3b: to -37.2 °C (-35 °F) USDA Zone 4a: to -34.4 °C (-30 °F) USDA Zone 4b: to -31.6 °C (-25 °F) USDA Zone 5a: to -28.8 °C (-20 °F) USDA Zone 5b: to -26.1 °C (-15 °F) USDA Zone 6a: to -23.3 °C (-10 °F) USDA Zone 6b: to -20.5 °C (-5 °F) USDA Zone 7a: to -17.7 °C (0 °F) USDA Zone 7b: to -14.9 °C (5 °F) USDA Zone 8a: to -12.2 °C (10 °F) USDA Zone 8b: to -9.4 °C (15 °F)"

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to Europe and western Asia; in Hawai'i naturalized in wet, open areas such as pastures and lawns, 820- 2,070 m, on Maui and Hawai'i First collected on Hawai'i in 1932 (Ewart III 232, BISH)." [Naturalized in mid- to upper elevation of the Hawaiian Islands]
	Duke, J. A. (1983). <i>Trifolium pratense</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html">https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html</a> . [Accessed ]	"Ranging from Boreal Moist to Wet through Subtropical Moist Forest Life Zones, red clover is reported to tolerate annual precipitation of 3.1 to 19.2 dm (mean of 91 cases = 8.6 dm), annual mean temperature of 4.9 to 20.3°C (mean of 91 cases = 10.6°C), and pH of 4.5 to 8.2 (mean of 84 cases = 6.3)."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to Europe and western Asia; in Hawai'i naturalized in wet, open areas such as pastures and lawns, 820-2,070 m, on Maui and Hawai'i."
	Lim, T. K. (2013). Edible Medicinal And Non-Medicinal Plants. Volume 7, Flowers. Springer, Dordrecht	"Red clover is indigenous to Europe, western Asia and northwest Africa but has been introduced and naturalized in many other parts of the world."

Qsn #	Question	Answer
301	Naturalized beyond native range	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i naturalized in wet, open areas such as pastures and lawns, 820-2,070 m, on Maui and Hawai'i. First collected on Hawai'i in 1932 (Ewart III 232, BISH)."
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. <a href="http://www.ars-grin.gov/npgs/index.html">http://www.ars-grin.gov/npgs/index.html</a> . [Accessed 4 Mar 2019]	"Naturalized (widely natzd. in temperate regions)"
	Lim, T. K. (2013). Edible Medicinal And Non-Medicinal Plants. Volume 7, Flowers. Springer, Dordrecht	"Red clover is indigenous to Europe, western Asia and northwest Africa but has been introduced and naturalized in many other parts of the world."

302	Garden/amenity/disturbance weed	y
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i naturalized in wet, open areas such as pastures and lawns, 820-2,070 m, on Maui and Hawai'i."
	Webb, C. J., Sykes, W. R., & Garnock-Jones, P. J. 1988. Flora of New Zealand Volume IV. Botany Division, DSIR, Christchurch, New Zealand	"Pasture, waste places, gardens, cultivated land."
	St. John, L., & Ogle, D. (2013). Plant Guide for Red clover ( <i>Trifolium pratense</i> ). USDA NRCS Plant Materials Center, Aberdeen, ID. <a href="https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf">https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf</a> . [Accessed 4 Mar 2019]	"Red clover may be spread by seed and may be considered weedy in some locations. It can spread into adjoining vegetative communities under ideal climatic and environmental conditions."
	Chace, T.D. 2013. How to Eradicate Invasive Plants. Timber Press, Portland, OR	"This very tenacious and successful plant often invades and completely intertwines with lawn grass and plants in flowerbeds and borders."
	White, M., Cheal, D., Carr, G. W., Adair, R., Blood, K. and Meagher, D. (2018). Advisory list of environmental weeds in Victoria. Arthur Rylah Institute for Environmental Research Technical Report Series No. 287. Department of Environment, Land, Water and Planning, Heidelberg, Victoria	" <i>Trifolium pratense</i> - Weed status in Victoria = Environmental weed" ... "Impact on natural systems = Rarely significant" [An environmental weed of rarely significant impacts. Conservatively designated here as a weed of potential environmental impacts]
	Queensland Government. (2019). Weeds of Australia. <i>Trifolium pratense</i> . <a href="http://keyserver.lucidcentral.org">http://keyserver.lucidcentral.org</a> . [Accessed 4 Mar 2019]	"Widely naturalised in southern and eastern Australia (i.e. in south-eastern Queensland, New South Wales, the ACT, Victoria, Tasmania, south-eastern South Australia and the coastal districts of south-western and southern Western Australia)." ... "Red clover ( <i>Trifolium pratense</i> ) is regarded as an environmental weed in Western Australia and Victoria." [Impacts unspecified. Conservatively designated here as a disturbance weed with potential negative environmental impacts]

303	Agricultural/forestry/horticultural weed	
	Source(s)	Notes

Qsn #	Question	Answer
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to Europe and western Asia; in Hawai'i naturalized in wet, open areas such as pastures and lawns, 820- 2,070 m, on Maui and Hawai'i." [Occurs in Hawaii pastures, but not regarded as an agricultural weed]
	White, M. R. (ed.). 2013. Invasive Plants and Weeds of the National Forests and Grasslands in the Southwestern Region. Second Edition. USDA Forest Service, Southwestern Region, Apache-Sitgreaves National Forests	"Red clover may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed, making it a concern in riparian and moist meadow habitats. This species generally occurs as a weed in wildland areas of the Southwestern Region rather than as an invasive plant."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Weed of: Cereals, Grapevines, Nursery Production, Orchards & Plantations, Pastures, Vegetables"

304	Environmental weed	
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i naturalized in wet, open areas such as pastures and lawns, 820- 2,070 m" [Not a serious weed of natural areas in the Hawaiian Islands]
	Hussey, B.M.J., Keighery, G. J., Dodd, J., Lloyd, S.G. & Cousens, R.D. 2007. Western Weeds. A Guide to the Weeds of Western Australia. The Weed Society of Western Australia, Victoria Park, WA	"Other clovers have been introduced to WA, and could be encountered as weeds. Consult a specialist text for details. The following have been recorded occasionally as naturalised: <i>T. cherleri</i> (cupped clover); <i>T. lappaceum</i> (lappa clover); <i>T. micranthum</i> (slender suckling clover); <i>T. ornithopodioides</i> (birdsfoot fenugreek); <i>T. pratense</i> (red clover); <i>T. spumosum</i> (bladder dover); <i>T. stellatum</i> (star clover) and <i>T. suffocatum</i> (suffocated clover)." [Not identified as a serious environmental weed of Australia]
	White, M., Cheal, D., Carr, G. W., Adair, R., Blood, K. and Meagher, D. (2018). Advisory list of environmental weeds in Victoria. Arthur Rylah Institute for Environmental Research Technical Report Series No. 287. Department of Environment, Land, Water and Planning, Heidelberg, Victoria	" <i>Trifolium pratense</i> - Weed status in Victoria = Environmental weed" ... "Impact on natural systems = Rarely significant" [An environmental weed of rarely significant impacts]
	Queensland Government. (2019). Weeds of Australia. <i>Trifolium pratense</i> . <a href="http://keyserver.lucidcentral.org">http://keyserver.lucidcentral.org</a> . [Accessed ]	"Widely naturalised in southern and eastern Australia (i.e. in south-eastern Queensland, New South Wales, the ACT, Victoria, Tasmania, south-eastern South Australia and the coastal districts of south-western and southern Western Australia)." ... "Red clover ( <i>Trifolium pratense</i> ) is regarded as an environmental weed in Western Australia and Victoria." [Impacts unspecified]
	Medeiros, A.C., Loope, L.L. & Chimera, C.G. 1998. Flowering Plants and Gymnosperms of Haleakala National Park. Technical Report 120. Pacific Cooperative Studies Unit, Honolulu, HI	[Not identified as an environmental weed in Haleakala National Park] " <i>Trifolium pratense</i> L. var. <i>sativum</i> Schreb. RED CLOVER West slope, stables area to old dump site, 6800 ft. This species is somewhat frost-sensitive, especially in drier sites here showing considerable dieback after repeated frosts."

305	Congeneric weed	y
	Source(s)	Notes

Qsn #	Question	Answer
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Trifolium alexandrinum ... Weed of: Orchards & Plantations, Pome Fruits" ... "Trifolium alpestre ... Weed of: Cereals" ... "Trifolium angustifolium ... Weed of: Cereals, Pastures" ... "Trifolium arvense... Weed of: Cereals, Lupins, Orchards & Plantations, Pastures" ... "Trifolium aureum ... Weed of: Cereals, Vegetables" ... "Trifolium campestre ... Weed of: Cereals, Orchards & Plantations, Pastures, Pome Fruits" ... "Trifolium cernuum ... Weed of: Pastures" ... "Trifolium clusii ... Weed of: Orchards & Plantations, Pome Fruits" ... "Trifolium dubium ... Weed of: Cereals, Orchards & Plantations, Pastures" ... "Trifolium echinatum ... Weed of: Cereals" ... "Trifolium fragiferum ... Weed of: Cereals, Orchards & Plantations" ... "Trifolium glomeratum ... Weed of: Pastures" ... "Trifolium hybridum ... Weed of: Cereals, Nursery Production, Orchards & Plantations" ... "Trifolium incarnatum ... Weed of: Cereals, Vegetables" ... "Trifolium lappaceum ... Weed of: Orchards & Plantations, Pome Fruits" ... "Trifolium medium ... Weed of: Cereals" ... "Trifolium patens ... Weed of: Pastures" ... "Trifolium pretense ... Weed of: Cereals, Grapevines, Nursery Production, Orchards & Plantations, Pastures, Vegetables" ... "Trifolium procumbens ... Weed of: Cereals" ... "Trifolium purpureum ... Weed of: Orchards & Plantations, Pome Fruits" ... "Trifolium resupinatum ... Weed of: Orchards & Plantations, Pastures, Pome Fruits" ... "Trifolium rubens ... Weed of: Cereals" ... "Trifolium rueppellianum ... Weed of: Orchards & Plantations" ... "Trifolium stellatum ... Weed of: Cereals, Orchards & Plantations, Pome Fruits" ... "Trifolium strepens ... Weed of: Cereals" ... "Trifolium striatum ... Weed of: Pastures" ... "Trifolium subterraneum ... Weed of: Cereals, Pastures" ... "Trifolium tomentosum ... Weed of: Cereals,
	UC IPM. 2014. White clover ( <i>Trifolium repens</i> ). Agriculture and Natural Resources, UC Davis, CA. <a href="http://www.ipm.ucdavis.edu/PMG/WEEDS/white_clover.html">http://www.ipm.ucdavis.edu/PMG/WEEDS/white_clover.html</a> . [Accessed 4 Mar 2019]	"White clover is a creeping perennial broadleaf plant. Except for deserts, it is found throughout California, to about 4900 feet (about 1500 m). White clover invades agricultural land and other disturbed sites."
	Virginia Tech Weed Identification Guide. 2016. White Clover: <i>Trifolium repens</i> . <a href="http://oak.ppws.vt.edu/">http://oak.ppws.vt.edu/</a> . [Accessed 4 Mar 2019]	"White clover is often planted in pasture and forage mixes but also occurs as a weed of lawns, turfgrass, landscapes, and orchards. White clover is found throughout the United States."

401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[No evidence] "Short-lived perennial herbs with taproots; stems usually decumbent, not rooting at the nodes, 0.5-10 dm long. Leaflets broadly elliptic, rhombic, or obovate, 15- 30(-50) mm long, 7 -15 mm wide, often with a reddish or dark patch, pubescent or upper surface glabrate, apex minutely denticulate, stipules oblong, adnate to petioles ca. 4/5 their length, triangular in upper part and abruptly contracted to the setaceous apex."

Qsn #	Question	Answer
402	<b>Allelopathic</b>	
	<b>Source(s)</b>	<b>Notes</b>
	McKenna, P., Cannon, N., Conway, J., Dooley, J., & Davies, W. P. (2018). Red clover ( <i>Trifolium pratense</i> ) in conservation agriculture: a compelling case for increased adoption. <i>International Journal of Agricultural Sustainability</i> , 16(4-5), 342-366	[Potentially Allelopathic] "Although these studies suggest that RC has the capacity to control weeds with allelopathic chemicals, in field studies it still remains uncertain if this control is caused by chemical action or other reasons, including the physical presence of residues on the topsoil."

403	Parasitic	n
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Short-lived perennial herbs with taproots; stems usually decumbent, not rooting at the nodes, 0.5-10 dm long." [Fabaceae. No evidence]

404	Unpalatable to grazing animals	n
	<b>Source(s)</b>	<b>Notes</b>
	Duke, J. A. (1983). <i>Trifolium pratense</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html">https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html</a> . [Accessed 4 Mar 2019]	"Extensively grown for pasturage, hay and green manure, considered excellent forage for livestock and poultry. Compared with alfalfa, red clover has about two-thirds as much digestible protein, slightly more total digestible nutrients, and slightly higher net energy value."
	Lim, T. K. (2013). <i>Edible Medicinal And Non-Medicinal Plants</i> . Volume 7, Flowers. Springer, Dordrecht	"Red clover is one of the richest sources of isoflavones. Red clover is widely grown as a pasture/ fodder crop. It is also used as a green manure crop as it enhances soil fertility by fixing nitrogen."
	St. John, L., & Ogle, D. (2013). <i>Plant Guide for Red clover (Trifolium pratense)</i> . USDA NRCS Plant Materials Center, Aberdeen, ID. <a href="https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf">https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf</a> . [Accessed 4 Mar 2019]	"Red clover is the most widely grown of all the true clovers and is the most important legume hay crop in the northeastern United States. Red clover is primarily used for hay, pasture, silage, and soil improvement. It is a quick growing crop, easily established, and produces high quality forage."

Qsn #	Question	Answer
405	<b>Toxic to animals</b>	
	<b>Source(s)</b>	<b>Notes</b>
	Fuller, T.C. & McClintock, E.M. 1986. Poisonous plants of California: Issue 53 of California natural history guides. University of California Press, Berkeley and Los Angeles, CA	"Symptoms: Infertility and an effect on the growth rate of animals; perhaps increased mastitis in cows. Unknown toxins cause photosensitization or "bighead." [ <i>Trifolium pratense</i> could contribute to these problems, although it has not been explicitly implicated]
	Lim, T. K. (2013). Edible Medicinal And Non-Medicinal Plants. Volume 7, Flowers. Springer, Dordrecht	[Potentially indirectly toxic] "The mycotoxin slaframine (1-acetoxy-6-aminooctahydroindolizine) was isolated from toxic red clover hay diseased by <i>Rhizoctonia leguminicola</i> (Hagler and Behlow 1981 ). Toxic hay caused extreme salivation, piloerection, lacrimation and respiratory distress and increased defecation when fed to guinea pigs. Similar effects were elicited with purified toxic red clover hay and pure slaframine."
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[Potentially toxic to animals under certain circumstances] "Cases of photosensitization have occurred. Ingesting of this plant can cause bloat in animals. This plant is also involved in a condition called congenital joint laxity and dwarfism. This disorder results in teratogenic problems in beef calves. Red clover can also develop phytoestrogens, which affect fertility in livestock."

406	Host for recognized pests and pathogens	
	<b>Source(s)</b>	<b>Notes</b>
		"Duke (1981a) lists many fungi, insects and nematodes plaguing red clover. Red clover is attacked by many fungi, some of which may cause serious losses. Among the fungi: <i>Alternaria tenuis</i> , <i>Ampelomyces quisqualis</i> , <i>Ascochyta trifolii</i> , <i>Botrytis anthopila</i> , <i>B. cinerea</i> , <i>Brachysporium trifolii</i> , <i>Cerospora zebrina</i> (summer black stem), <i>Chaetomium cochliodes</i> , <i>Colletotrichum destructivum</i> , <i>C. trifolii</i> (southern anthracnose), <i>Corticium solani</i> , <i>Cylindrocladium scoparium</i> , <i>Cymadothea trifolii</i> , <i>Didymella trifolii</i> , <i>Didymium sturgisii</i> , <i>Erysiphe communis</i> f. <i>trifolii</i> , <i>E. martii</i> , <i>E. polygoni</i> (powdery mildew), <i>Fusarium acuminatum</i> , <i>F. avenaceum</i> , <i>F. equiseti</i> , <i>F. gramineum</i> , <i>F. oxysporum</i> (root rot), <i>F. pose</i> , <i>F. roseum</i> , <i>F. solani</i> , <i>Kabatiella caulivora</i> (northern anthracnose), <i>Leptosphaerulina americana</i> , <i>L. briosiana</i> , <i>L. trifolii</i> , <i>Metasphaeria boucera</i> , <i>Microsphaeria alni</i> , <i>Mycosphaerella carinthiaca</i> , <i>Oidium erysiphoides</i> , <i>Ophiobolus collapsus</i> , <i>O. graminis</i> , <i>Peronospora pratensis</i> , <i>P. trifoliorum</i> , <i>Phoma trifolii</i> (spring black stem), <i>Phyllachora trifolii</i> , <i>Phymatotrichum omnivorum</i> , <i>Phytophthora cactorum</i> , <i>Phyllosticta trifolii</i> , <i>Plenodomus melioli</i> , <i>Pleospora herbarum</i> , <i>Polythrincium trifolii</i> , <i>Pseudopeziza trifolii</i> , <i>Pseudoplea medicaginis</i> , <i>P. trifolii</i> (pepper spot), <i>Pyrenopeziza jonesii</i> , <i>Pythium debaryanum</i> , <i>Rhizoctonia crocorum</i> , <i>Rh. leguminicola</i> (black patch), <i>Rh. solani</i> , <i>Rh. violacea</i> , <i>Sclerotinia kitajimana</i> , <i>S. sclerotiorum</i> , <i>S. spermophila</i> , <i>S. trifoliorum</i> (crown rot), <i>Septoria compta</i> , <i>Sporonema phacidioides</i> , <i>S. trifolii</i> , <i>Sphaerulina trifolii</i> , <i>Stagonospora compta</i> , <i>S. melioli</i> , <i>S. recedens</i> , <i>Stemphylium sarcinaeforme</i> (target spot), <i>S. botryosum</i> , <i>Sclerotium delphinii</i> , <i>S. rolfsii</i> , <i>S. bataticola</i> , <i>Stictis pustulata</i> , <i>Thielaviopsis basicola</i> , <i>Thyrospora sarcinaeformis</i> , <i>Uromyces fallens</i> , <i>U. minor</i> , <i>U. nerviphilus</i> , <i>U. trifolii</i> , <i>U. trifolii-repentis</i> , <i>Vermicularis dematium</i> , <i>Verticillium dichotomum</i> , and <i>Volutella fusarioides</i> . Red clover's life

Duke, J. A. (1983). *Trifolium pratense*. Handbook of Energy Crops. [https://hort.purdue.edu/newcrop/duke\\_energy/Trifolium\\_pratense.html](https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html). [Accessed 5 Mar 2019]

cycle may be shortened by buildups of *Fusarium*, *Gliocladium*, and *Rhizoctonia* in the soil. Since it is impractical to control diseases with fungicides, stress is placed on finding or developing disease resistant cvs. Bacteria causing diseases in red clover include: *Bacillus lathryi* (red clover streak), *Pseudomonas radiciperda*, and *Ps. syringae*. Parasitic on red clover are *Cuscuta epithimum* and *C. pentagona*. Viruses causing diseases in red clover include the following: bean yellow mosaic (BYMV), red clover vein mosaic (*Marmor trifolii*), clover mosaic, Pisum virus 2, Lucerne mosaic, *Trifolium virus 1*, common pea mosaic, clover phyllody virus, rugose leaf curl, tobacco mosaic, white clover mosaic, and potato calico (*Marmor medicaginis* var. *solani*). The most promising method for control of many red clover diseases is development of resistant cvs. Some progress has been made in developing cvs resistant to northern and southern anthracnose and powdery mildew. For control methods, local agents should be consulted. Nematodes isolated from red clover include: *Acrobeles ciliatus*, *Acrobelloides emarginatus*, *Aphelenchoides ritzemabosi*, *Aphelenchus avenae*, *Boleodorus thylactus*, *Cephalobus* spp., *Chiloplacus* spp., *Criconemella curvata*, *C. lobata*, *C. rustica*, *Ditylenchus destructor*, *D. dipsaci*, *Eucephalobus* spp., *Helicotylenchus cairnsi*, *H. canadensis*, *H. digonicus*, *H. dihystra*, *H. multicinctus*, *H. pseudorobustus*, *Heterodera davertii*, *H. glycines*, *H. goettingiana*, *H. lespedezae*, *H. trifolii*, *Hoplolaimus galeatus*, *H. tylenchiformis*, *Longidorus elongatus*, *L. maximus*, *Meloidogyne arenaria*, *M. artiellia*, *M. hapla*, *M. incognita*, *M. i. acrita*, *M. javanica*, *Merlinius brevidens*, *M. macrurus*, *Neotylenchus* spp., *Paratylenchus aciculus*, *P. brevihastus*, *P. hamatus*, *P. projectus*, *P. sarissus*, *P. tenuicaudatus*, *Pratylenchus brachyurus*, *P. coffeae*, *P. neglectus*, *P. penetrans*, *P. pratensis*, *P. scribneri*, *P. tumidiceps*, *Psilenchus hilarulus*, *Pungentus pungens*, *Rotylenchulus reniformis*, *Rotylenchus goodeyi*, *R. robustus*, *Scutellonema brachyurum*, *Trichodorus christiei*, *Tylencholaimus mirabilis*, *Tylenchorhynchus agri*, *T. annulatus*, *T. claytoni*, *T. dubius*, *T. maximus*, *T. parvus*, *Tylenchus costatus*, *T. davainii*, and *Xiphinema americanum*. Amos and Taylor (1975) showed that *Tylenchorhynchus agri*, which feeds only on the epidermal cells in the region of root elongation, actually stimulates the growth. The most destructive insects reported on red clover include the following: clover root borer (*Hylastinus obscurus*), clover root curculio (*Sitona hispidulus*), clover seed chalcid (*Bruchophagus gibbus*), lesser clover leaf weevil (*Hypera nigrirostris*), potato leafhopper (*Empoasca fabae*), yellow clover aphid (*Therioaphis trifolii*), meadow spittlebug (*Philaenus spumarius*), clover seed midge (*Dasineura leguminicola*) clover leafhopper (*Aceratagallia sanguinolenta*), and pea aphid (*Acyrtosiphon pisum*). "No practical controls of these insects are available." (Taylor and Smith, 1981)."

St. John, L., & Ogle, D. (2013). Plant Guide for Red clover (*Trifolium pratense*). USDA NRCS Plant Materials Center, Aberdeen, ID. [https://plants.usda.gov/plantguide/pdf/pg\\_trpr2.pdf](https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf). [Accessed 5 Mar 2019]

"There are also reports of reproductive problems in sheep which graze solid stands of red clover. This is caused by the high levels of estrogen in the plant, occurs infrequently, and is rare with grass/red clover mixtures. Spring applications of nitrogen will stimulate grass and provide early feed, but excessive rates are detrimental to the clover stand. Phosphate applications are broadcast in fall or spring according to soil tests. Sulfur, boron, or magnesium may be needed for maximum production on some soils in the western part of red clover's range. Pests and Potential Problems Red Clover is subject to many disease and insect problems. Crown rot, root rot, anthracnose and powdery mildew may be problems in areas with high humidity

		and rainfall. Viral diseases such as bean yellow mosaic virus, stem blackening diseases and black patch also occur. Choose disease resistant cultivars to reduce the occurrence of these problems. Red clover is attacked by many insects including the clover root borer, clover root curculio, clover seed chalcid, clover weevils, aphids, midges, and leaf hoppers."
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<b>407</b>	<b>Causes allergies or is otherwise toxic to humans</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[Potentially toxic to animals under certain circumstances] "Cases of photosensitization have occurred. Ingesting of this plant can cause bloat in animals. This plant is also involved in a condition called congenital joint laxity and dwarfism. This disorder results in teratogenic problems in beef calves. Red clover can also develop phytoestrogens, which affect fertility in livestock. Flowering tops alterative, antispasmodic, detergent, diuretic, expectorant, sedative and tonic, used to treat blood disorders, boils, arthritis, stomachache. Plant infusion for whooping cough, cough, eczema, psoriasis, menopausal complaints, fevers, kidney problems, blood purifier. Veterinary medicine, used as fodder to increase lactation and also for reducing tiredness."

<b>408</b>	<b>Creates a fire hazard in natural ecosystems</b>	<b>n</b>
	<b>Source(s)</b>	<b>Notes</b>
	Lim, T. K. (2013). Edible Medicinal And Non-Medicinal Plants. Volume 7, Flowers. Springer, Dordrecht	"Red clover favours cool weather conditions. It is well-adapted to a wide range of soil types and conditions. It tolerate wet conditions but thrives best in well-drained fertile soils. It is found in meadows, wet and dry grassland, woodland, forest margins, field borders, roadsides and paths and widely planted as pastures." [Unlikely given habitat and habit]
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Short-lived perennial herbs with taproots" ... "in Hawai'i naturalized in wet, open areas such as pastures and lawns" [No evidence. Unlikely given habit & habitat]

<b>409</b>	<b>Is a shade tolerant plant at some stage of its life cycle</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	St. John, L., & Ogle, D. (2013). Plant Guide for Red clover ( <i>Trifolium pratense</i> ). USDA NRCS Plant Materials Center, Aberdeen, ID. <a href="https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf">https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf</a> . [Accessed 4 Mar 2019]	"Red clover has good shade tolerance (approximately 6% of daylight) which makes companion cropping with red clover fairly successful. Its tolerance to shade allows red clover to be used as a cover crop under corn for silage."
	Dave's Garden. (2019). <i>Trifolium</i> Species, Red Clover - <i>Trifolium pratense</i> . <a href="https://davesgarden.com/guides/pf/go/31462/">https://davesgarden.com/guides/pf/go/31462/</a> . [Accessed 4 Mar 2019]	"Sun Exposure: Full Sun, Sun to Partial Shade"

<b>410</b>	<b>Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>

Qsn #	Question	Answer
	Duke, J. A. (1983). <i>Trifolium pratense</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html">https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html</a> . [Accessed 4 Mar 2019]	"Grows best on well-drained loam soil, but also adapted to wetter soils. Most soils that produce good crops of corn, tobacco or small grains will also produce a good crop of red clover. Loams, silt loams, and even fairly heavy soils are better than light sandy or gravelly soils. Some of these soils may need lime or fertilizer, or both. Red clover is most productive on soil that is within a pH range of 6.6 to 7.6. It also needs P and K to produce good yields; amounts needed can be determined by soil tests."
	Lim, T. K. (2013). <i>Edible Medicinal And Non-Medicinal Plants</i> . Volume 7, Flowers. Springer, Dordrecht	"Red clover favours cool weather conditions. It is well-adapted to a wide range of soil types and conditions. It tolerate wet conditions but thrives best in well-drained fertile soils."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Short-lived perennial herbs with taproots; stems usually decumbent, not rooting at the nodes, 0.5-10 dm long."

412	Forms dense thickets	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"in Hawai'i naturalized in wet, open areas such as pastures and lawns" [No evidence]
	St. John, L., & Ogle, D. (2013). Plant Guide for Red clover ( <i>Trifolium pratense</i> ). USDA NRCS Plant Materials Center, Aberdeen, ID. <a href="https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf">https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf</a> . [Accessed 5 Mar 2019]	"Red clover may be spread by seed and may be considered weedy in some locations. It can spread into adjoining vegetative communities under ideal climatic and environmental conditions." [No evidence]
	White, M. R. (ed.). 2013. <i>Invasive Plants and Weeds of the National Forests and Grasslands in the Southwestern Region</i> . Second Edition. USDA Forest Service, Southwestern Region, Apache-Sitgreaves National Forests	"Red clover may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed, making it a concern in riparian and moist meadow habitats. This species generally occurs as a weed in wildland areas of the Southwestern Region rather than as an invasive plant." [No evidence of dense thickets or cover, despite descriptions of weediness]
	Duke, J. A. (1983). <i>Trifolium pratense</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html">https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html</a> . [Accessed 5 Mar 2019]	[No evidence] "Native on wet to dry meadows, open forests, forest margins, field borders, and paths."

501	Aquatic	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Terrestrial] "Short-lived perennial herbs with taproots... in Hawai'i naturalized in wet, open areas such as pastures and lawns, 820-2,070 m"

502	Grass	n
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. <a href="http://www.ars-grin.gov/npgs/index.html">http://www.ars-grin.gov/npgs/index.html</a> . [Accessed 4 Mar 2019]	Family: Fabaceae (alt.Leguminosae) Subfamily: Faboideae Tribe: Trifolieae

503	Nitrogen fixing woody plant	n
	<b>Source(s)</b>	<b>Notes</b>
	Lim, T. K. (2013). Edible Medicinal And Non-Medicinal Plants. Volume 7, Flowers. Springer, Dordrecht	"A herbaceous pubescent to glabrescent perennial, with erect to ascending stems, 20–80 cm high and with a fairly deep tap root." ... "It is also used as a green manure crop as it enhances soil fertility by fixing nitrogen." [Non woody N-fixing herb]

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Short-lived perennial herbs with taproots"

601	Evidence of substantial reproductive failure in native habitat	n
	<b>Source(s)</b>	<b>Notes</b>
	Lim, T. K. (2013). Edible Medicinal And Non-Medicinal Plants. Volume 7, Flowers. Springer, Dordrecht	[No evidence] "Red clover is indigenous to Europe, western Asia and northwest Africa but has been introduced and naturalized in many other parts of the world."

602	Produces viable seed	y
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Pods ovoid, enclosed in calyx, irregularly circumscissile. Seeds 1(2), yellow or brownish, ovoid, 1.5-2 mm long."
	St. John, L., & Ogle, D. (2013). Plant Guide for Red clover ( <i>Trifolium pratense</i> ). USDA NRCS Plant Materials Center, Aberdeen, ID. <a href="https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf">https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf</a> . [Accessed 4 Mar 2019]	"Red clover may be spread by seed and may be considered weedy in some locations."
	Duke, J. A. (1983). <i>Trifolium pratense</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html">https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html</a> . [Accessed 4 Mar 2019]	"Seeds ca. 600,000/kg" ... "Most red clover is spring seeded in a crop of fall- or spring-sown small grain. In the early spring the soil alternately freezes and thaws, thus covering the seed with soil."

603	Hybridizes naturally	
	<b>Source(s)</b>	<b>Notes</b>

Qsn #	Question	Answer
	<p>Honkanen J. &amp; Ryöppy P. (1989) Somatic Hybridization in Trifolium. In: Bajaj Y.P.S. (eds) Plant Protoplasts and Genetic Engineering I. Biotechnology in Agriculture and Forestry, vol 8. Springer, Berlin, Heidelberg</p>	<p>"The clovers (<i>Trifolium</i> spp.) belong to the family Leguminosae. There are some 300 species within the genus, distributed all over the world, but mostly in the northern temperate and subtropical zones. They are grown for hay, pasture or soil improvement, usually in mixtures with grasses except when intended for seed production. Species belong to numerous sections and subsections between which hybrid barriers are very strong (Taylor 1980). Very few natural hybrids between species are known, although species within sections can be hybridized by applying the embryo rescue technique (Merker 1984)."</p>
	<p>Isobe, S., Sawai, A., Yamaguchi, H., Gau, M., &amp; Uchiyama, K. (2002). Breeding potential of the backcross progenies of a hybrid between <i>Trifolium medium</i> × <i>T. pratense</i> to <i>T. pratense</i>. <i>Canadian Journal of Plant Science</i>, 82(2), 395-399</p>	<p>[Artificial hybrids possible] "Introgression of genes for longevity from perennial <i>Trifolium</i> species to <i>T. pratense</i> is a potential means for improving the persistence of <i>T. pratense</i>. Various hybridizations with <i>T. pratense</i> have been carried out with several species: <i>T. pallidum</i> [Palestine clover (Armstrong and Cleveland 1970)], <i>T. diffusum</i> (Taylor et al. 1963; Schwer and Cleveland 1972), <i>T. hirtum</i> [Rose clover (Schwer and Cleveland 1972)], <i>T. sarosense</i> (Phillips et al. 1982; Collins et al. 1983), <i>T. alpestre</i> [Purple glove clover (Merker 1988; Phillips et al. 1992)], and <i>T. medium</i> [Zigzag clover (Merker 1982); Nedbalkova et al. 1995; Sawai et al. 1990, 1995]. Although many hybrids have been successfully produced, there have been no reports of hybrid plants being used as germplasm in conventional breeding programs."</p>

Qsn #	Question	Answer
604	Self-compatible or apomictic	
	Source(s)	Notes
	McKenna, P., Cannon, N., Conway, J., Dooley, J., & Davies, W. P. (2018). Red clover ( <i>Trifolium pratense</i> ) in conservation agriculture: a compelling case for increased adoption. <i>International Journal of Agricultural Sustainability</i> , 16(4-5), 342-366	"RC is a bee-pollinated plant with a gametophytic self-incompatibility system (Townsend & Taylor, 1985), a profile which typically causes a high degree of intraspecific diversity. This has been consistently observed in RC wild populations and ecotypes (Dias, Julier, Sampoux, Barre, & Dall'Agnol, 2008; Pagnotta, Annicchiarico, Farina, & Proietti, 2011; Ulloa, Ortega, & Campos, 2003) and means that the end products of different breeding programs exhibit high degrees of diversity."
	Kendall, W. A., & Taylor, N. L. (1969). Effect of temperature on pseudo-self-compatibility in <i>Trifolium pratense</i> L. <i>Theoretical and Applied Genetics</i> , 39(3), 123-126	[Potentially Yes under certain conditions] "A relatively high temperature treatment, applied during anthesis, was shown to enhance self seed production through pseudo-self-compatibility in normally self-incompatible red clover ( <i>Trifolium pratense</i> L.). The self-seeds were produced in cultures of excised stems held in 2.5 percent sucrose. The stems were excised when petal color was beginning to appear in the buds. During anthesis the cultures were incubated with the flower heads at 40 ° and the stems at 25 °C. When most of the florets per head had opened the cultures were transferred to 20 °C and held at that temperature during the period of pollen growth through the styles and also during seed development. The addition of calcium nitrate and boric acid to the culture medium did not enhance anthesis, seed weight, or the number of seeds produced. Plant genotype and the environment provided before anthesis were the primary factors influencing the number of self-seed produced. Although not all attempts to produce self-seed have been successful, with repeated trials all clones we tested produced some seed."

605	Requires specialist pollinators	n
	Source(s)	Notes
	St. John, L., & Ogle, D. (2013). Plant Guide for Red clover ( <i>Trifolium pratense</i> ). USDA NRCS Plant Materials Center, Aberdeen, ID. <a href="https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf">https://plants.usda.gov/plantguide/pdf/pg_trpr2.pdf</a> . [Accessed 4 Mar 2019]	"Bumblebees are especially important in pollinating red clover but are sometimes inadequate to insure a good seed crop. Honey bees also pollinate red clover but tend to prefer sweetclover, white clover and alsike clover if these species are in the vicinity."
	Lim, T. K. (2013). Edible Medicinal And Non-Medicinal Plants. Volume 7, Flowers. Springer, Dordrecht	"Flowers 30–70, in dense globose or ovoid, terminal, sessile to shortly pedunculate heads, subtended by involucre of stipules (Plates 2, 3, and 4). Calyx with subulate teeth, pubescent or glabrous. Corolla purple or dark pink, standard spatulate, ovary elliptic." [Not specialized]
	Duke, J. A. (1983). <i>Trifolium pratense</i> . Handbook of Energy Crops. <a href="https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html">https://hort.purdue.edu/newcrop/duke_energy/Trifolium_pratense.html</a> . [Accessed 4 Mar 2019]	"In most areas it is necessary to pollinate with bees, using 5 to 8 strong colonies of bees per hectare." ... "Red clover is pollinated by honeybees and bumblebees."

606	Reproduction by vegetative fragmentation	y
	Source(s)	Notes

Qsn #	Question	Answer
	Heuzé, V., Tran, G., Giger-Reverdin, S., & Lebas, F. 2015. Red clover ( <i>Trifolium pratense</i> ). Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. <a href="https://www.feedipedia.org/node/246">https://www.feedipedia.org/node/246</a> . [Accessed 4 Mar 2019]	"Basal buds form a crown above the soil and may root at the nodes. Each bud produces 4-6 upright, hollow and pubescent stems, up to a height of 60-80 cm."
	Chace, T.D. 2013. How to Eradicate Invasive Plants. Timber Press, Portland, OR	"REPRODUCTION - Seeds, plus the stems root easily at the nodes."

607	Minimum generative time (years)	1
	Source(s)	Notes
	Duke, J. A. 1981. Handbook of Legumes of World Economic Importance. Plenum Press, New York	[Annual or biennial] "In northeastern United States and Canada, and at higher elevation in southeastern and western United States, red clover grows as a biennial or short-lived perennial; at lower elevations in southeastern United States, it grows as a winter annual, and at lower elevation in western United States and Canada, it grows under irrigation as a biennial. "

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Dispersed by: Humans, Animals, Flyers, Cattle, Donkey, Horse, Livestock, Sheep, Vehicles, Water, Wind, Escapee"
	Zwaenepoel, A., Roovers, P., & Hermy, M. (2006). Motor vehicles as vectors of plant species from road verges in a suburban environment. <i>Basic and Applied Ecology</i> , 7(1), 83-93	"Table 2. Total number of germinable seeds in mud attached to cars, based on 20 randomly selected cars from a university car park in Ghent and sampled on 12 occasions between October 1988 and September 1989" [Includes 1 seedling of <i>Trifolium pratense</i> ]

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	Lim, T. K. (2013). Edible Medicinal And Non-Medicinal Plants. Volume 7, Flowers. Springer, Dordrecht	"Red clover is indigenous to Europe, western Asia and northwest Africa but has been introduced and naturalized in many other parts of the world."

703	Propagules likely to disperse as a produce contaminant	
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Major Pathway/s: Contaminant, Crop, Forestry, Herbal, Ornamental, Pasture Dispersed by: Humans, Animals, Flyers, Cattle, Donkey, Horse, Livestock, Sheep, Vehicles, Water, Wind, Escapee Seed Longevity: Long Term Weed of: Cereals, Grapevines, Nursery Production, Orchards & Plantations, Pastures, Vegetables" [Possibly. Reported to be an agricultural weed, so there is potential to become a seed contaminant]

704	Propagules adapted to wind dispersal	
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Qsn #	Question	Answer
	<b>Source(s)</b>	<b>Notes</b>
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Dispersed by: Humans, Animals, Flyers, Cattle, Donkey, Horse, Livestock, Sheep, Vehicles, Water, Wind, Escapee"
	Nature Picture Library. (2019). Red clover seeds ( <i>Trifolium pratense</i> ). <a href="https://www.naturepl.com">https://www.naturepl.com</a> . [Accessed 5 Mar 2019]	"Red clover seeds ( <i>Trifolium pratense</i> ) - Europe. Plant-eating mammals, ants and earthworms are partly responsible for seed dispersal, and the seeds also carry dried remnants of the former flower, which act as sails for wind dispersal."
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Seeds 1(2), yellow or brownish, ovoid, 1.5-2 mm long." [Seeds lack adaptations for wind dispersal, but small size may facilitate some movement by wind]

705	Propagules water dispersed	y
	<b>Source(s)</b>	<b>Notes</b>
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Dispersed by: Humans, Animals, Flyers, Cattle, Donkey, Horse, Livestock, Sheep, Vehicles, Water, Wind, Escapee"
	White, M. R. (ed.). 2013. Invasive Plants and Weeds of the National Forests and Grasslands in the Southwestern Region. Second Edition. USDA Forest Service, Southwestern Region, Apache-Sitgreaves National Forests	"Red clover may become weedy or invasive in some regions or habitats and may displace desirable vegetation if not properly managed, making it a concern in riparian and moist meadow habitats." [Weed of riparian habitats. Likely dispersed by water]

706	Propagules bird dispersed	n
	<b>Source(s)</b>	<b>Notes</b>
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Pods ovoid, enclosed in calyx, irregularly circumscissile. Seeds 1(2), yellow or brownish, ovoid, 1.5-2 mm long." [Unlikely. Not fleshy-fruited, although potential for external dispersal exists]
	Czarnecka, J. & Kitowski, I. 2013: The white stork as an engineering species and seed dispersal vector when nesting in Poland. <i>Annales Botanici Fennici</i> 50: 1-12	"The most common exozoochorous mechanism was secretion of mucilage and seed adhesion, which are typical for some very abundant species (e.g., <i>Plantago major</i> , <i>Urtica dioica</i> , <i>Trifolium pratense</i> and <i>T. repens</i> )." [Externally bird-dispersed. No evidence of internal dispersal]

Qsn #	Question	Answer
707	<b>Propagules dispersed by other animals (externally)</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Hovstad, K. A., Borvik, S., & Ohlson, M. (2009). Epizoochorous seed dispersal in relation to seed availability—an experiment with a red fox dummy. <i>Journal of Vegetation Science</i> , 20(3), 455-464	"In modern agricultural landscapes, large herbivores are often restricted in their mobility or are found at low densities, and other animal vectors may therefore be important for seed dispersal. In our study, a range of plant species were able to disperse by attaching seeds to, and having their seeds retained in, the fox fur some distance. We suggest that the red fox may be an important vector for epizoochorous seed dispersal in the agricultural landscape." ... "Fig. 2. Proportion of the ten original seeds (mean, n56) remaining after walking the fox dummy 50m (light grey) and 500m (dark grey). The experiment was conducted in a low-growing pasture and the vegetation did not touch the seeds on the fox." [Includes <i>Trifolium pratense</i> ]
	Czarnecka, J. & Kitowski, I. 2013: The white stork as an engineering species and seed dispersal vector when nesting in Poland. <i>Annales Botanici Fennici</i> 50: 1-12	"The most common exzoochorous mechanism was secretion of mucilage and seed adhesion, which are typical for some very abundant species (e.g., <i>Plantago major</i> , <i>Urtica dioica</i> , <i>Trifolium pratense</i> and <i>T. repens</i> )." [Externally bird-dispersed]

708	<b>Propagules survive passage through the gut</b>	<b>y</b>
	<b>Source(s)</b>	<b>Notes</b>
	Randall, R.P. (2017). <i>A Global Compendium of Weeds</i> . 3rd Edition. Perth, Western Australia. R.P. Randall	"Dispersed by: Humans, Animals, Flyers, Cattle, Donkey, Horse, Livestock, Sheep, Vehicles, Water, Wind, Escapee"
	Picard, M., Papaïx, J., Gosselin, F., Picot, D., Bideau, E., & Baltzinger, C. (2015). Temporal dynamics of seed excretion by wild ungulates: implications for plant dispersal. <i>Ecology and Evolution</i> , 5(13), 2621-2632	"Using a comparative experimental approach, we quantified endozoochorous seed retention times and germination rates for six plant species abundant in western Europe and frequently consumed by wild ungulates ( <i>Calluna vulgaris</i> L., <i>Juncus effusus</i> L., <i>Plantago media</i> L., <i>Prunella vulgaris</i> L., <i>Rubus fruticosus</i> L., and <i>Trifolium pratense</i> L.)." ... "In roe deer, seeds of <i>Juncus effusus</i> , <i>Calluna vulgaris</i> , and <i>Trifolium pratense</i> were excreted faster than other seeds (Fig. 4B and Table 2). In red deer, we observed roughly the same pattern. The seeds of <i>Trifolium pratense</i> and <i>Calluna vulgaris</i> were excreted first" ... "In wild boar, retention times were globally homogenous, although <i>Juncus effusus</i> and <i>Trifolium pratense</i> tended to be excreted later than the other species"

801	<b>Prolific seed production (&gt;1000/m2)</b>	
	<b>Source(s)</b>	<b>Notes</b>
	Duke, J. A. 1981. <i>Handbook of Legumes of World Economic Importance</i> . Plenum Press, New York	"pods oblong-ovoid, circumscissile; seeds ovoid, asymmetrical, yellowish to purplish. Seeds ca. 600,000/kg" [Possibly in cultivation. Unlikely in natural settings]
	Reiné, R., Chocarro, C., & Fillat, F. (2004). Soil seed bank and management regimes of semi-natural mountain meadow communities. <i>Agriculture, Ecosystems &amp; Environment</i> , 104(3), 567-575	[No evidence from cultivated sites in Spain] "Table 1 - Mean number of seed per square meter area in four meadows of the Spanish Pyrenees" [ <i>Trifolium pratense</i> - Intensive irrigated = 124.73 ± 37.02; Intensive unirrigated = 62.36 ± 24.81; Extensive cut = 207.88 ± 49.00; Extensive uncut = 62.36 ± 28.87]

Qsn #	Question	Answer
802	Evidence that a persistent propagule bank is formed (>1 yr)	y
	Source(s)	Notes
	Royal Botanic Gardens Kew. (2019) Seed Information Database (SID). Version 7.1. Available from: <a href="http://data.kew.org/sid/">http://data.kew.org/sid/</a> . [Accessed 6 Mar 2019]	"Storage Behaviour: Orthodox Storage Conditions: A few seeds survive following 81 years in herbarium (Turner, 1933); seeds are safely stored in liquid nitrogen (Stanwood & Bass, 1981); average germination change 92 to 91.8%, 20 years storage at -15°C with 60% r.h., 61 collections (Rinker, 1983); p50= 5.36 years for seeds under open storage in a temperate climate (Priestley, 1986); long-term storage under IPGRI preferred conditions at RBG Kew, WP. Oldest collection 20 years; average germination change 93.4 to 98.7%, mean storage period 13 years, 23 collections"
	Toole, E. H., & Brown, E. (1946). Final results of the Duvel buried seed experiment. <i>Journal of Agricultural Research</i> , 72, 201-10	[39 year viability] "This report completes the records of the experiment begun in 1902 and ended in 1941. Probably the ability of seeds to persist in the soil is connected with dormancy which may be due to reduced oxygen supply or lack of some form of mechanical treatment. There are marked irregularities in the percentages of germination of the same species from different depths and for succeeding years; these may be due to local differences in environment. There is a general tendency for seeds buried at a greater depth (42 inches) to produce more seedlings than seeds buried in a shallower layer of soil (8 inches). Seeds of crop plants having large seeds did not persist for even 1 year, whereas seeds of small seeded plants ( <i>Trifolium pratense</i> and <i>Poa pratensis</i> ) retained viability after 39 years."
	Lewis, J. (1973). Longevity of crop and weed seeds: survival after 20 years in soil. <i>Weed Research</i> 13: 179-191	A low percentage of seeds survive in undisturbed soil for 20 years

803	Well controlled by herbicides	y
	Source(s)	Notes
	Hall, E. 2007. Red clover. Pastures Australia <a href="https://keys.lucidcentral.org/keys/v3/pastures/Html/Red_clover.htm">https://keys.lucidcentral.org/keys/v3/pastures/Html/Red_clover.htm</a> . [Accessed 6 Mar 2019]	"Red clover is sensitive to commonly used hormone type herbicides such as MCPA and 2,4-D. Herbicides containing 2,4-DB can be used."
	Burdon, J. (1983). <i>Trifolium repens</i> L. <i>Journal of Ecology</i> , 71(1), 307-330	[Methods at controlling related taxon would likely be effective with <i>Trifolium pratense</i> ] "A number of nonselective herbicides have been successful in controlling or eliminating many perennial species including <i>T. repens</i> . The Ontario Herbicide Committee (1978) recommends the following applications: diuron, simazine and atrazine all at 15-20 kg in 750 L/ha; sodium chlorate mixtures at 1 kg/10 m; ammate X at 1 kg/ 15 m <sup>2</sup> bromacil at 5-10 kg/ha; amizine at 10 kg/ha; and bromacil + diuron at 10-13 kg/ha. Both the B. C. (Anonymous 1977) and the Ontario Herbicide Committee (1978) recommend mecoprop (MCP) at 1 kg/ha, along with a number of 2,4-D mixtures e.g. 2,4-D dicamba, 2,4-D dichloroprop, and 2,4-D/fenoprop/dicamba, for control of white clover in turfs. Haggard (1974) manipulated the white clover content in swards by applying various grass-suppressing herbicides such as carbetamide, dalapon, propyzamide, and paraquat."

Qsn #	Question	Answer
	Young-Mathews, A. 2013. Plant guide for crimson clover ( <i>Trifolium incarnatum</i> ). USDA-Natural Resources Conservation Service, Plant Materials Center, Corvallis, OR	[Methods at controlling related taxon would likely be effective with <i>Trifolium pratense</i> ] "Crimson clover is easily killed mechanically by mowing or by spraying with herbicide after early bud stage, but N gains are maximized by waiting until late bloom or early seed set (Clark, 2007). If spraying as part of a conservation tillage system, a systemic herbicide will produce a more complete kill than a contact herbicide (Owsley, 2012)."
	Zandstra, B., Particka, M. & Masabni, J. 2004. Guide to Tolerance of Crops and Susceptibility of Weeds to Herbicides. Extension Bulletin E-2833. Michigan State University, East Lansing, Michigan	Clopyralid, glufosinate, glyphosate reported to achieve excellent post-emergent control. Hexazinone and oxyfluorfen reported to give fair pre and post-emergent control.

804	Tolerates, or benefits from, mutilation, cultivation, or fire	
	Source(s)	Notes
	Hall, E. 2007. Red clover. Pastures Australia <a href="https://keys.lucidcentral.org/keys/v3/pastures/Html/Red_clover.htm">https://keys.lucidcentral.org/keys/v3/pastures/Html/Red_clover.htm</a> . [Accessed 6 Mar 2019]	"When grown for hay, cutting red clover at the early flowering stage (¼ to ½ in bloom) maximises the yield and feed value. Generally three cuts (subsequent cuts at ¼ bloom) of hay can be expected per year provided there is adequate fertility and moisture. Lenient grazing in the first year will enhance production and persistence (leave at least 5 cm of growth). Rotational grazing will improve persistence. Red clover is sensitive to set stocking for long periods. Avoid overgrazing in winter, as this will hasten the thinning of stands."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R. & Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	[Unknown] "Native to Europe and western Asia; in Hawai'i naturalized in wet, open areas such as pastures and lawns, 820-2,070 m, on Maui and Hawai'i. First collected on Hawai'i in 1932 (Ewart III 232, BISH)."

**Summary of Risk Traits:**

## High Risk / Undesirable Traits

- Broad climate suitability and elevation range exceeds 1000 m, demonstrating environmental versatility
- A temperate plant that can grow in subtropical climates
- Naturalized on Maui and Hawaii, Hawaiian Islands, and widely naturalized elsewhere
- A lawn and disturbance weed that may have adverse impacts on agriculture and the natural environment (but not considered a problem in the Hawaiian Islands)
- Other *Trifolium* species are invasive weeds
- Consumption by animals may cause problems in certain situations
- Shade-tolerant
- Tolerates many soil types (potential to invade not limited by substrate)
- Reproduces by seed and vegetatively by rooting at nodes
- A biennial, but may reach maturity in < 1 year in some areas
- Seeds dispersed internally and externally by animals, by water, and bot accidentally and intentionally by people
- Seeds form a persistent seed bank. Some seeds may persist for 20-30+ years.
- May tolerate some mowing and grazing

## Low Risk Traits

- Despite naturalization and reports of weediness, generally not regarded as a problematic agricultural or environmental weed in the Hawaiian Islands
- Unarmed (no spines, thorns, or burrs)
- Provides fodder for livestock
- Mostly self-incompatible (although selfing has been documented in some cloned plants)
- Herbicides may provide effective control if removal is desired