

Taxon: Lotus corniculatus L.	Family: Fabaceae
Common Name(s): bird's foot trefoil	Synonym(s): Lotus ambiguus Besser ex Spreng. Lotus balticus Miniaev Lotus carpetanus Lacaita Lotus corniculatus subsp. major Lotus corniculatus var. major (Scop.) Lotus komarovii Miniaev Lotus major Scop. Lotus olgae Klokov Lotus ruprechtii Miniaev Lotus tauricus Juz. Lotus zhegulensis Klokov

Assessor: Chuck Chimera	Status: Assessor Approved	End Date: 19 Feb 2019
WRA Score: 16.0	Designation: H(HPWRA)	Rating: High Risk

Keywords: Perennial Herb, Environmental Weed, Fodder, Ballistic Dispersal, Prolific Seeder

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	n=0, y = 2*multiplier (see Appendix 2)	y
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	y
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
402	Allelopathic	y=1, n=0	n
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals		
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	n
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	y
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	n
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	y=1, n=-1	y
704	Propagules adapted to wind dispersal	y=1, n=-1	n
705	Propagules water dispersed		
706	Propagules bird dispersed		
707	Propagules dispersed by other animals (externally)	y=1, n=-1	n
708	Propagules survive passage through the gut	y=1, n=-1	y
801	Prolific seed production (>1000/m ²)	y=1, n=-1	y
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	y=1, n=-1	y

Qsn #	Question	Answer Option	Answer
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
	Bush, T. (2006). Plant Fact Sheet - Birdsfoot trefoil - <i>Lotus corniculatus</i> L. USDA NRCS Rose Lake Plant Materials Center, Lansing, Michigan. https://plants.usda.gov/factsheet/pdf/fs_loco6.pdf . [Accessed 18 Feb 2019]	[Cultivars have been bred, but not domesticated] "Some of the most common upright or hay-type varieties used in the Northeast US are 'Norcen', 'Viking', 'Mansfield', and 'Leo'. 'Empire', 'Dawn', and 'Fergus' are low-growing, pasture-type varieties. The European trefoil is not a variety, but merely refers to trefoil seed imported from Europe. European trefoil is lower yielding than the US varieties and this seed is not recommended. 'Cascade' (France), 'Granger', 'Mackinaw' (IA naturalized), and 'Kalo' (France) are principal cultivars in the west. Seed is readily available at commercial seedhouses."
	Jones, D., & Turkington, R. (1986). <i>Lotus corniculatus</i> L. <i>Journal of Ecology</i> , 74(4), 1185-1212	[Not domesticated] " <i>Lotus corniculatus</i> is an important plant in agronomy, and the genetic basis is known for many characters showing continuous or discontinuous variation"

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

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

Qsn #	Question	Answer
	<p>USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 15 Feb 2019]</p>	<p>"Native Africa NORTHERN AFRICA: Algeria (n.), Morocco, Tunisia NORTHEAST TROPICAL AFRICA: Ethiopia, Sudan EAST TROPICAL AFRICA: Kenya, Tanzania Asia-Temperate WESTERN ASIA: Afghanistan, Cyprus, Iran, Iraq, Turkey CAUCASUS: Armenia, Azerbaijan, Georgia, Russian Federation, [Dagestan] Russian Federation-Ciscaucasia [Ciscaucasia] SIBERIA: Russian Federation-Western Siberia [Western Siberia (s.w.)] MIDDLE ASIA: Kazakhstan, Tajikistan, Turkmenistan MONGOLIA: Mongolia RUSSIAN FAR EAST: Russian Federation [Primorye] CHINA: China EASTERN ASIA: Japan, Korea, Taiwan Asia-Tropical INDIAN SUBCONTINENT: India, Nepal, Pakistan Europe NORTHERN EUROPE: Denmark, Finland, Ireland, Norway, Sweden, United Kingdom MIDDLE EUROPE: Austria, Belgium, Czechoslovakia, Germany, Hungary, Netherlands, Poland, Switzerland EASTERN EUROPE: Belarus, Estonia, Latvia, Lithuania, Moldova, Russian Federation-European part, [European part] Ukraine (incl. Krym) SOUTHEASTERN EUROPE: Albania, Bulgaria, Former Yugoslavia, Greece, Romania SOUTHWESTERN EUROPE: France, Spain"</p>

202	Quality of climate match data	High
	Source(s)	Notes
	<p>USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 15 Feb 2019]</p>	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	<p>Plants for a Future. (2019). <i>Lotus corniculatus</i>. https://pfaf.org/user/Plant.aspx?LatinName=Lotus+corniculatus. [Accessed 18 Feb 2019]</p>	<p>"USDA hardiness: 3-8" [6 hardiness zones]</p>
	<p>Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2010. Flora of China. Vol. 10 (Fabaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis</p>	<p>[Elevation range of 3000 m, demonstrating environmental versatility] "Pinus plantations, thickets, scrub, damp meadows, alpine meadows, dry hill pastures, grassy places, rocky slopes, ravines, river valleys, banks, roadsides, abandoned fields, cultivated ground; 400–3400 m."</p>

Qsn #	Question	Answer
204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"In the tropics, bird's-foot trefoil is found only in mountainous regions (Clapham et al. 1962)."
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 18 Feb 2019]	[Range reported within tropical regions] "Native Africa NORTHERN AFRICA: Algeria (n.), Morocco, Tunisia NORTHEAST TROPICAL AFRICA: Ethiopia, Sudan EAST TROPICAL AFRICA: Kenya, Tanzania Asia-Temperate WESTERN ASIA: Afghanistan, Cyprus, Iran, Iraq, Turkey CAUCASUS: Armenia, Azerbaijan, Georgia, Russian Federation, [Dagestan] Russian Federation-Ciscaucasia [Ciscaucasia] SIBERIA: Russian Federation-Western Siberia [Western Siberia (s.w.)] MIDDLE ASIA: Kazakhstan, Tajikistan, Turkmenistan MONGOLIA: Mongolia RUSSIAN FAR EAST: Russian Federation [Primorye] CHINA: China EASTERN ASIA: Japan, Korea, Taiwan Asia-Tropical INDIAN SUBCONTINENT: India, Nepal, Pakistan Europe NORTHERN EUROPE: Denmark, Finland, Ireland, Norway, Sweden, United Kingdom MIDDLE EUROPE: Austria, Belgium, Czechoslovakia, Germany, Hungary, Netherlands, Poland, Switzerland EASTERN EUROPE: Belarus, Estonia, Latvia, Lithuania, Moldova, Russian Federation-European part, [European part] Ukraine (incl. Krym) SOUTHEASTERN EUROPE: Albania, Bulgaria, Former Yugoslavia, Greece, Romania SOUTHWESTERN EUROPE: France, Spain"

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	Grant, W. F. & Niizeki, M. (2009). Birdsfoot Trefoil (<i>Lotus corniculatus</i> L.). Pp. 153-206 in Singh, R. J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement:: Forage Crops, Volume 5. CRC Press, Boca Raton, FL	"Birdsfoot trefoil is widely distributed in Europe (Chrtkova-Zertova 1973) and has become extensively colonized in North America (Zandstra and Grant 1968; Table 6.1)."
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2010. Flora of China. Vol. 10 (Fabaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"introduced in Australia (including Tasmania), North, Central, and South America, and Pacific islands (New Zealand)]."

Qsn #	Question	Answer
301	Naturalized beyond native range	y
	Source(s)	Notes
	Grant, W. F. & Niizeki, M. (2009). Birdsfoot Trefoil (<i>Lotus corniculatus</i> L.). Pp. 153-206 in Singh, R. J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement:: Forage Crops, Volume 5. CRC Press, Boca Raton, FL	" <i>Lotus corniculatus</i> L. is a Eurasian tetraploid (2n = 4x = 24) perennial forage legume found in wild and naturalized populations throughout temperate regions of Europe, Asia Minor, North Africa, North and South America, Australia, and New Zealand"
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 15 Feb 2019]	"Naturalized Australasia AUSTRALIA: Australia NEW ZEALAND: New Zealand Northern America Canada, United States Southern America South America (s.)"
	Burrows, G. E., & Tyrl, R. J. (2013). Toxic Plants of North America. Second Edition. Wiley-Blackwell, Hoboken, NJ	"The best known species of the genus, <i>L. corniculatus</i> , is widely used as a hay and forage crop. Native to Eurasia, it has escaped and is naturalized in meadows, roadsides, lawns, waste areas, and other disturbed sites across North America (Bryson and DeFelice 2010)."
	Wagner, W.L., Herbst, D.R.& Lorence, D.H. (2019). Flora of the Hawaiian Islands. Smithsonian Institution, Washington, D.C. http://botany.si.edu/ . [Accessed 18 Feb 2019]	No evidence from Hawaiian Islands to date

302	Garden/amenity/disturbance weed	y
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"In Italian vineyards, vine sprout growth showed 24% inhibition when <i>L. corniculatus</i> was present (Zanardi 1962). Although <i>L. corniculatus</i> is not a serious agricultural weed, it is a common weed in turf, sports surfaces (Fryer and Makepeace 1977), on lawns, and along roadsides (Crockett 1977)."

303	Agricultural/forestry/horticultural weed	y
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Weed of: Cereals, Forestry, Grapevines, Orchards & Plantations, Pastures, Vegetables"
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	[Minor agricultural weed] "In Italian vineyards, vine sprout growth showed 24% inhibition when <i>L. corniculatus</i> was present (Zanardi 1962). Although <i>L. corniculatus</i> is not a serious agricultural weed, it is a common weed in turf, sports surfaces (Fryer and Makepeace 1977), on lawns, and along roadsides (Crockett 1977)."

304	Environmental weed	y
	Source(s)	Notes

Qsn #	Question	Answer
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Naturalized plants in Australia are referred to as <i>Lotus corniculatus</i> var. <i>corniculatus</i> (State of Queensland, 2014). The plant forms dense mats, crowding out native vegetation. With its dense fibrous roots in the topsoil it prevents establishment of native plants. The plant has the potential to outcompete native plants especially on infertile soils." ... "In Victoria, Australia, <i>Lotus corniculatus</i> spreads in a number of plant communities of high conservation value, e.g. floodplain forests, peatlands, and swamps (State of Queensland, 2014). The plant invades native prairies in the arid midwest of the USA. Regular prescribed burning in these areas facilitates seed germination of this weed (Minnesota Department of Natural Resources, 2014). "

305	Congeneric weed	y
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	" <i>Lotus glaber</i> ... Weed of: Orchards & Plantations" ... " <i>Lotus maroccanus</i> ... Weed of: Cereals" ... " <i>Lotus purshianus</i> ... Weed of: Grapevines, Orchards & Plantations, Pome Fruits" ... " <i>Lotus tenuis</i> ... Weed of: Cereals, Grapevines, Orchards & Plantations, Pastures"

401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2010. Flora of China. Vol. 10 (Fabaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[No evidence] "Herbs, perennial, 15–80 cm, with a taproot, scattered sparsely white puberulent or glabrescent. Stem cylindrical to angular, solid, decumbent or ascending. Leaflets 5, apical 3 obovate to oblanceolate-obovate (lateral 2 oblique), 5–20 × 4–10 mm, papery, basal 2 stipulelike, midrib obscure. Umbels rarely more than 7-flowered; peduncle 3–10 cm; sterile bract with 1–3 leaflets, ± equal to calyx, 5–7 mm."

402	Allelopathic	n
	Source(s)	Notes
	Grant, W. F. & Niizeki, M. (2009). Birdsfoot Trefoil (<i>Lotus corniculatus L.</i>). Pp. 153-206 in Singh, R. J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement:: Forage Crops, Volume 5. CRC Press, Boca Raton, FL	[Birdsfoot trefoil is reported to be affected by allelopathic properties of other plants] "Allelopathic toxins have been implicated in reduction of new forage stands. Such toxins may explain some of the difficulty in establishing birdsfoot trefoil in tall fescue sod (Luu, Matches, and Peters 1982). This suggests that it may be desirable to grow one or more crops between a sod crop and no-till legumes (Vough, Decker, and Taylor 1995). Luu (1980) found that toxins associated with tall fescue swards were largely eliminated by burning the sod prior to seeding birdsfoot trefoil."

Qsn #	Question	Answer
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	[No evidence, and allelopathy not identified as a factor in its competitive ability] " <i>Lotus corniculatus</i> is a common species in open meadows, fields, lawns, along roadsides, and in waste places. In North American pastures, it grows well with <i>Danthonia spicata</i> (L.) Beauv., <i>Poa compressa</i> L., <i>Festuca elatior</i> (MacDonald 1946), <i>Bromus inermis</i> Leys., <i>Dactylis glomerata</i> L. and <i>Poa pratensis</i> L. (Parsons and Davis 1964). Bird's-foot trefoil is particularly compatible with <i>Onobrychis viciaefolia</i> Scop. (Cooper 1972), and slow-establishing grasses such as <i>Phleum pratense</i> L., which offer less intense competition at the seedling stage (Chevrette et al. 1960)." ... "Bird's-foot trefoil outcompetes other legumes and many grasses on infertile, saline, acidic, chalky, dry, and water-logged soils by virtue of its deep taproot and dense, shallow root system, its spreading habit, perennial nature, winterhardiness, and resistant "hard seeds." However, on fertile soil, it is a less successful competitor, its root system being less vigorous and its seed yield being depressed when grown with brome grass, orchardgrass, tall fescue, and timothy (Winch 1958). In addition, the seedlings of bird's-foot trefoil are small, non-aggressive, and slow-growing, and are therefore easily out competed (Cooper 1967)."

403	Parasitic	n
	Source(s)	Notes
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2010. Flora of China. Vol. 10 (Fabaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Herbs, perennial, 15–80 cm, with a taproot, scattered sparsely white puberulent or glabrescent." [Fabaceae. No evidence]

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"Bird's-foot trefoil has been used as forage for cattle in England since 1744 and in Switzerland since 1865."
	Grant, W. F. & Niizeki, M. (2009). Birdsfoot Trefoil (<i>Lotus corniculatus</i> L.). Pp. 153-206 in Singh, R. J. (ed.). Genetic Resources, Chromosome Engineering, and Crop Improvement:: Forage Crops, Volume 5. CRC Press, Boca Raton, FL	"In eastern North America, <i>L. corniculatus</i> has emerged from an introduced weed in the 1920s to become a successful secondary forage crop (Beuselinck and Grant 1995). It is widely grown in temperate climates in Europe and North and South America for pasture or for hay and silage production"
	Bush, T. (2006). Plant Fact Sheet - Birdsfoot trefoil - <i>Lotus corniculatus</i> L. USDA NRCS Rose Lake Plant Materials Center, Lansing, Michigan. https://plants.usda.gov/factsheet/pdf/fs_loco6.pdf . [Accessed 18 Feb 2019]	"Wildlife: Birdsfoot trefoil is a choice food for Canada goose, deer, and elk. As ground cover, it provides green cover most of the year and blooms profusely. It is used for pheasant cover on shooting preserves and around ponds at duck clubs. Livestock: This species is used for green chop, hay and pasture. It is seeded in combination with grass and grazed as a non-bloating legume. It yields 4 tons of hay per acre on deep, well drained soils receiving irrigation or adequate rainfall. As a dryland pasture legume, birdsfoot trefoil produces 20% more growth after July 1 than most dryland grass legume mixtures."

405	Toxic to animals	

Qsn #	Question	Answer
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"It contains potentially toxic amounts of cyanogenic substances (Crockett 1977), although this is usually not a problem (Whyte et al. 1953)."
	Burrows, G. E., & Tyrl, R. J. (2013). Toxic Plants of North America. Second Edition. Wiley-Blackwell, Hoboken, NJ	[Possibly in some situations, but generally considered non-toxic] " <i>L. corniculatus</i> is highly palatable and nutritious and has a reputation as a bloat -safe legume (Martin et al. 1987; Howarth et al. 1991). Although the plant is not generally thought of as toxic, cases of cyanide poisoning have been reported from other areas of the world (Everist 1981)." ... "Experimentally, an extract of foliage of <i>L. corniculatus</i> was lethal to sheep when given in large amounts via ruminal cannulae (Dougherty and Christensen 1953). The extract contained 55.2 – 66.5 mg cyanide/100 mL. Its removal by distillation eliminated or substantially reduced toxicity of the plant extract."

406	Host for recognized pests and pathogens	
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"" 'Few insects or diseases were found to seriously affect bird's-foot trefoil" (MacDonald 1946). This statement is supported by Whyte et al. (1953) and Watkin and Winch (1969). Seaney and Henson (1970) found that although viruses cause no serious damage to bird's-foot trefoil, they may weaken the plants , making them more susceptible to other pathogens. Similarly, insects such as the trefoil seed chalcid <i>Bruchophagus gibbus</i> cause little damage to the trefoil plant, but may destroy up to 50% of the seed produced (Neunzig 1957). The Dawn variety of <i>Lotus corniculatus</i> is more resistant to root rot fungi than either Viking or Empire (Seaney and Henson 1970). Table I lists some parasites found on bird's-foot trefoil growing in Canada; Pettit et al. (1969) , Kainski (1960), and Neunzig and Gyrisco (1955) list additional parasites found growing on bird's-foot trefoil in the U.S.A."
	Bush, T. (2006). Plant Fact Sheet - Birdsfoot trefoil - <i>Lotus corniculatus</i> L. USDA NRCS Rose Lake Plant Materials Center, Lansing, Michigan. https://plants.usda.gov/factsheet/pdf/fs_loco6.pdf . [Accessed]	"Crown and root rots are the most significant diseases of birdsfoot trefoil. The trefoil seed chalcid, <i>Bruchophagus kolobovae</i> Fed., is a small, black, wasp-like insect that can be destructive in seed fields."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"Plant vulnerary. Leaf juice applied to treat cuts and wounds. Seeds to cure skin problems"
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	[Potentially toxic to animals. No evidence to humans] "It contains potentially toxic amounts of cyanogenic substances (Crockett 1977), although this is usually not a problem (Whyte et al. 1953)."

408	Creates a fire hazard in natural ecosystems	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	[No evidence. Generally does not occur in high fire risk habitats] "Trefoil is adapted to extended rainfall in temperate and tropical regions and to summer or winter seasonal rain (Whyte et al. 1953)."
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	Not listed among impacts

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"Bird's-foot trefoil is adapted to medium light intensity; studies have shown that low light intensity inhibits both top and root growth (Gist and Mott 1957), lowers leaf to stem ratios (Rhykerd et al. 1959), and lowers the leaf area per plant (McKee 1962)."
	Plants for a Future. (2019). <i>Lotus corniculatus</i> . https://pfaf.org/user/Plant.aspx?LatinName=Lotus+corniculatus . [Accessed 19 Feb 2019]	"It cannot grow in the shade."

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"Bird's-foot trefoil "may be found in any soil or situation which is not strongly shaded, very sour, or continuously water-logged, whilst on. poor, dry soil at high altitude it is more likely to succeed than any other leguminous plant" (Robinson 1934). Although bird's-foot trefoil grows on poorly drained, thin, droughty, infertile, and acid soils it shows most vigorous growth on moist, heavy, fertile, limey soil of pH 6.5 (Smith 1975). It has been reported growing at pH 4. 9 on Codorus silt loam in Maryland (Hunt and Wagoner 1963), on saline soils (Ayers 1948), on bare chalk (Usher 1975), clay (Seaney and Henson 1970), sand dunes (Waughman 1972), on dry rocky slopes (Boulihac 1925), in water-logged-acidic to dry-alkaline conditions (Whyte et al. 1953), and on 55-yr-old waste areas of a Somerset coalfield (Down 1973). In Britain it is commonly found close to the seaside and in grassy areas (Butcher 1961)."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2010. Flora of China. Vol. 10 (Fabaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"Herbs, perennial, 15–80 cm, with a taproot, scattered sparsely white puberulent or glabrescent. Stem cylindrical to angular, solid, decumbent or ascending."

Qsn #	Question	Answer
412	Forms dense thickets	y
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"The plant forms dense mats, crowding out native vegetation. With its dense fibrous roots in the topsoil it prevents establishment of native plants. The plant has the potential to outcompete native plants especially on infertile soils."

501	Aquatic	n
	Source(s)	Notes
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2010. Flora of China. Vol. 10 (Fabaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[Terrestrial] "Herbs, perennial, 15–80 cm, with a taproot, scattered sparsely white puberulent or glabrescent." ... "Pinus plantations, thickets, scrub, damp meadows, alpine meadows, dry hill pastures, grassy places, rocky slopes, ravines, river valleys, banks, roadsides, abandoned fields, cultivated ground; 400–3400 m."

502	Grass	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2019. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 15 Feb 2019]	Family: Fabaceae (alt.Leguminosae) Subfamily: Faboideae Tribe: Loteae

503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	[Primarily herbaceous nitrogen fixing plant. May become woody with age] "A perennial having a long taproot (occasionally up to 1 m), becoming woody with age, with many secondary lateral branches which form a thick fibrous mat"

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Not a geophyte, but taproot allows plant to persist] "Once established, the weed persists owing to the strong taproot."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	[No evidence. Widely distributed] "It is widely distributed throughout the U.S.A. (Crockett 1977) and most of Europe to 71°N (Clapham et al. 1962) and to an altitude of 3050 m in the Swiss Alps (MacDonald 1946). It occurs in India, Siberia, and in many parts of Africa and South America."

Qsn #	Question	Answer
602	Produces viable seed	y
	Source(s)	Notes
	Bush, T. (2006). Plant Fact Sheet - Birdsfoot trefoil - <i>Lotus corniculatus L.</i> USDA NRCS Rose Lake Plant Materials Center, Lansing, Michigan. https://plants.usda.gov/factsheet/pdf/fs_loco6.pdf . [Accessed 18 Feb 2019]	"For forage production birdsfoot trefoil is typically seeded at 4 to 8 pounds per acre either alone or with a grass. Seeding rates for erosion control practices may run considerably higher depending on the mix and geographic location."
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Seed production is high and can reach 18,000 seeds per plant Jones and Turkington, 1986."

603	Hybridizes naturally	n
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus L.</i> Canadian Journal of Plant Science, 60(3), 965-979	[Artificial hybrids possible. No natural hybrids reported] "Grant (1965) lists 45 interspecific crosses made within the genus <i>Lotus</i> including four crosses with <i>Lotus corniculatus</i> successful in setting seed: <i>L. corniculatus</i> x <i>L. tenuis</i> , x <i>L. pedunculatus</i> , x <i>L. palustris</i> , and x <i>L. coimbrensis</i> . Somaroo and Grant (1971) produced four additional fertile hybrids by crossing <i>L. corniculatus</i> var. <i>minor</i> with <i>L. alpinus</i> , <i>L. filicaulis</i> , <i>L. krylovii</i> , and with <i>L. japonicus</i> . No natural hybrids have been reported although Grant et al. (1962) review the pertinent literature."

604	Self-compatible or apomictic	
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus L.</i> Canadian Journal of Plant Science, 60(3), 965-979	[Low levels of self-pollination. Artificial self-pollination increases seed seed.] "Silow (1931) found that spontaneous self-pollination is rare in bird's-foot trefoil, and obtained only 8.7- 30. 3 seeds per 100 flowers in the absence of insects. When the flowers were artificially self-pollinated, the seed yield increased to a maximum of 416 seeds per 100 flowers, this number being less than one-tenth the number of seeds formed as a result of cross-pollination."

605	Requires specialist pollinators	n
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus L.</i> Canadian Journal of Plant Science, 60(3), 965-979	" <i>Lotus corniculatus</i> is primarily cross-pollinated (Tome and Johnston 1945). Insects of the Hymenoptera, particularly the large bumblebees, are "the only effective pollinators" (Knuth 1908); Bader and Anderson (1962) found that pollen-collecting bees are more efficient than nectar-collecting bees. When visiting a flower the insect depresses the wing and keel petals which forces the pollen from the top half of the keel as a "worm-like pasty mass"; this adheres to the underside of the insect (Robinson 1947). The number of visible seeds set per pod increases with the number of visits to the floret by the bee and the time spent by each bee at the floret (Bader and Anderson 1962)."

Qsn #	Question	Answer
	Jones, D., & Turkington, R. (1986). <i>Lotus corniculatus</i> L. <i>Journal of Ecology</i> , 74(4), 1185-1212	"The breeding system is complex, but cross-pollination is usual (Tome & Johnson 1945). According to Knuth (Poll. 2), Hymenoptera, particularly the larger <i>Bombus</i> spp., are 'the only effective pollinators'; Free (1970) agreed, but under experimental conditions <i>Apis mellifera</i> has been observed to be an effective pollinator (D. A. Jones and I. M. Taylor, unpublished)."

606	Reproduction by vegetative fragmentation	y
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. <i>Canadian Journal of Plant Science</i> , 60(3), 965-979	"The plant can also spread rhizomatously to form relatively large colonies (Grant 1967)."

607	Minimum generative time (years)	1
	Source(s)	Notes
	Morris, P., Carron, T. R., Robbins, M. P., & Webb, K. J. (1993). Distribution of condensed tannins in flowering plants of <i>Lotus corniculatus</i> var. <i>japonicus</i> and tannin accumulation by transformed root cultures. <i>Lotus Newsletter</i> , 24, 60-63	[Other varieties likely reach maturity in <1 year] " <i>Lotus comiculatus</i> var <i>japonicus</i> is a small, diploid (2n= 12), self fertile and profusely flowering perennial which gives good seed set (ca 29 seeds/pod) and has a short generation time (3 months from seed to seed)."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	Notes
	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, Goat, Horse, Livestock, Sheep, Vehicles, Water, Wind, Escapee"
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. <i>Canadian Journal of Plant Science</i> , 60(3), 965-979	[Common in heavily trafficked areas] "Bird's-foot trefoil is an agricultural escapee and is often continuous over large areas of roadside and waste places."
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2010. <i>Flora of China</i> . Vol. 10 (Fabaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[Seeds lack means of external attachment, but are small and could adhere to vehicles, equipment or footwear in soil] "Seeds light to dark brown, 1-colored or spotted with violet-black spots or dots, small, ovoid, 1–1.7 mm." ... "Pinus plantations, thickets, scrub, damp meadows, alpine meadows, dry hill pastures, grassy places, rocky slopes, ravines, river valleys, banks, roadsides, abandoned fields, cultivated ground"

702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2010. <i>Flora of China</i> . Vol. 10 (Fabaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	"introduced in Australia (including Tasmania), North, Central, and South America, and Pacific islands (New Zealand)]."

Qsn #	Question	Answer
	Bush, T. (2006). Plant Fact Sheet - Birdsfoot trefoil - <i>Lotus corniculatus</i> L. USDA NRCS Rose Lake Plant Materials Center, Lansing, Michigan. https://plants.usda.gov/factsheet/pdf/fs_loco6.pdf . [Accessed 19 Feb 2019]	"Uses Erosion control: Birdsfoot trefoil is used along roadsides to control wind and water erosion. Wildlife: Birdsfoot trefoil is a choice food for Canada goose, deer, and elk. As ground cover, it provides green cover most of the year and blooms profusely. It is used for pheasant cover on shooting preserves and around ponds at duck clubs. Livestock: This species is used for green chop, hay and pasture. It is seeded in combination with grass and grazed as a non-bloating legume. It yields 4 tons of hay per acre on deep, well drained soils receiving irrigation or adequate rainfall. As a dryland pasture legume, birdsfoot trefoil produces 20% more growth after July 1 than most dryland grass legume mixtures."

703	Propagules likely to disperse as a produce contaminant	y
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"It is one of the most common seed impurities of white clover (Robinson 1947) and low-grade grass seed (Jones 1977)."

704	Propagules adapted to wind dispersal	n
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"Bird's-foot trefoil has an effective method of seed dispersal. As a result of the rupturing of two sutures along the pod, the two halves of the pod twisted spirally and violently eject the seeds."

705	Propagules water dispersed	
	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, Goat, Horse, Livestock, Sheep, Vehicles, Water, Wind, Escapee"
	Wu, Z. Y., P. H. Raven & D. Y. Hong, eds. 2010. Flora of China. Vol. 10 (Fabaceae). Science Press, Beijing, and Missouri Botanical Garden Press, St. Louis	[Possibly yes when growing in riparian habitats] "Pinus plantations, thickets, scrub, damp meadows, alpine meadows, dry hill pastures, grassy places, rocky slopes, ravines, river valleys, banks, roadsides, abandoned fields, cultivated ground"

706	Propagules bird dispersed	
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	[Possibly yes, although primarily dispersed ballistically and by passing through grazing animals] "Hard seeds" may over-winter and germinate the following spring and may pass through the digestive tract of sheep, cattle, and birds unharmed (Grant 1967)." ... "Bird's-foot trefoil has an effective method of seed dispersal. As a result of the rupturing of two sutures along the pod, the two halves of the pod twisted spirally and violently eject the seeds."

707	Propagules dispersed by other animals (externally)	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	[Seeds primarily dispersed ballistically and internally by animals] "Hard seeds" may over--winter and germinate the following spring and may pass through the digestive tract of sheep, cattle, and birds unharmed (Grant 1967)." ... "Bird's-foot trefoil has an effective method of seed dispersal. As a result of the rupturing of two sutures along the pod, the two halves of the pod twisted spirally and violently eject the seeds."

708	Propagules survive passage through the gut	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, Goat, Horse, Livestock, Sheep, Vehicles, Water, Wind, Escapee"
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"Hard seeds" may over--winter and germinate the following spring and may pass through the digestive tract of sheep, cattle, and birds unharmed (Grant 1967)."

801	Prolific seed production (>1000/m2)	y
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Seed production is high and can reach 18,000 seeds per plant Jones and Turkington, 1986)."
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"Under optimal conditions, <i>Lotus corniculatus</i> may yield 675-1125 kg seed per hectare, with an average of 20 seeds per pod and five pods per inflorescence. The weight of 1000 seeds has been estimated to be from 1. 29 g (MacDonald 1946) to 1. 57 g (Robinson 194 7)."

802	Evidence that a persistent propagule bank is formed (>1 yr)	y
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus</i> L. Canadian Journal of Plant Science, 60(3), 965-979	"MacDonald (1946) described a study on the decrease in viability of bird's-foot trefoil seeds with age. While 1-yr-old seed resulted in 80% to 90% germination, this decreased to 84% with 2-yr-old, 69% with 3 -yr-old, 57% with 5-yr-old, 27% with 7-yr-old, 10% with 9-yr-old, and only 7% with 11-yr-old seed."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Seed Longevity: Long Term"
	Milberg, P. (1995). Soil seed bank after eighteen years of succession from grassland to forest. <i>Oikos</i> , 72(1): 3-13	"Two species were lost from the vegetation in both treatments between 1973 and 1991 (Table 1). In addition, eight were lost from ungrazed plots only, and four from grazed plots only. In a few of these cases, seeds were still present in the soil (<i>Campanula rotundifolia</i> , <i>Lotus corniculatus</i> , <i>Scrophularia nodosa</i> and <i>Stellaria graminea</i>)."

803	Well controlled by herbicides	y
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Qsn #	Question	Answer
	Source(s)	Notes
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus L.</i> Canadian Journal of Plant Science, 60(3), 965-979	"A number of herbicides are successful in controlling or eliminating <i>Lotus corniculatus</i> at the seedling stage. Bromocil, Isocil, and Atrazine at 2.2-36 kg/ha and Simazine and Diuron at 18-36 kg/ha effectively controlled bird's-foot trefoil within 1 yr in Oregon (Brown et al. 1964). Seedling stage control has also been obtained with four combinations of the herbicides Atrazine, Bentagon, Cyanazine, Paraquat, and Simazine in north-eastern U.S.A. cornfields (Hartwig and Hoffman 1975), and 2,4-D with MCPA at a rate of 2 kg/ha (Street and Bayer 1971). Willis and Thompson (1975) found no response by bird's-foot trefoil to the nematocid carbofuran or to the fungicide benomyl. Some varieties of <i>Lotus corniculatus</i> have developed a tolerance to certain herbicides; this tolerance is genetically controlled (Seaney and Henson 1970). Fertig et al. (1960) found that the Empire variety is more tolerant than the Viking variety to spring and fall applications of 2,4-D, 2,4-DB, and silvex. Through recurrent selection, Devine et al. (1975) developed a genetic strain of <i>Lotus corniculatus</i> that is more tolerant to 2,4-D than established trefoil varieties."
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Effective herbicides for chemical control are clopyralid, glyphosate or triclopyr (Czarapata, 2005)."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	Y
	Source(s)	Notes
	Weber, E. 2017. Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Once established, the weed persists owing to the strong taproot." ... "Mechanical control includes frequent mowing close to the ground for several years. Plants of small infestations can be dug out; all root fragments should be removed."
	Turkington, R. O. Y., & Franko, G. D. (1980). The biology of Canadian weeds. 41. <i>Lotus corniculatus L.</i> Canadian Journal of Plant Science, 60(3), 965-979	"Since carbohydrate root reserves are low throughout the growing season and bird's-foot trefoil growth is dependent upon carbohydrate production by the leaves, the repeated removal of a large percentage of the top growth by cutting or grazing will eventually starve the plant (Smith 1962) and prevent seed development (Fryer and Makepeace 1977). However, crown removal stimulates the production of adventitious buds and shoots from the root, thereby increasing its potential for survival (Smith 1975)."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	WRA Specialist. (2019). Personal Communication	Unknown

Summary of Risk Traits:

High Risk / Undesirable Traits

- Elevation range exceeds 1000 m, and able to grow in 5 hardiness zones, demonstrating environmental versatility
- A temperate species that can grow in higher elevation tropical regions
- Naturalized in Australia, New Zealand, North and South America (but no evidence in Hawaiian Islands to date)
- A disturbance-adapted weed with negative impacts on agriculture and the natural environment
- Other Lotus species have become invasive
- Contains potentially toxic amounts of cyanogenic substances (although usually not a problem for grazing animals)
- Tolerates many soil types
- Can form dense cover that may exclude or outcompete other vegetation
- Reproduces primarily by seeds, but also by rhizomes
- Primarily self-incompatible (but low levels of seed set by selfed plants)
- Able to reach maturity in 3 months
- Seeds dispersed by ballistic dispersal, inadvertently along heavily trafficked areas, internally by animals, potentially by water, and intentionally planted by people
- Prolific seed production
- Forms a persistent seed bank
- Once established, tolerates repeated grazing and mowing

Low Risk Traits

- Primarily a temperate species; may only be a risk at higher elevations of tropical and subtropical islands
- Unarmed (no spines, thorns, or burrs)
- Provides fodder for livestock
- Light-demanding
- Herbicides may provide effective control