Taxon: Solanum linnaeanum Hepper & P.-M. L. Jaeger **Family:** Solanaceae

Common Name(s): apple of Sodom
black spine nightshade
poison apple
Sodom apple
thorny popolo

Synonym(s): Solanum hermannii Dunal
Solanum sodomeum (Misapplied)

Assessor: Chuck Chimera **Status:** Assessor Approved **End Date:** 30 Aug 2022

WRA Score: 20.0 **Designation:** H(Hawai'i) **Rating:** High Risk

Keywords: Naturalized Shrub, Pasture Weed, Prickly, Toxic Properties, Dense Stands

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)	High
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		
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	y
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	y
405	Toxic to animals	y=1, n=0	y
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	y

Qsn #	Question	Answer Option	Answer
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)		
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		
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	n
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	2
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	n
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	n
801	Prolific seed production (>1000/m2)		
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**
	Vorontsova, M. S., & Knapp, S. (2016). A Revision of the" Spiny Solanums," Solanum Subgenus Leptostemonum (Solanaceae), in Africa and Madagascar. Systematic Botany Monographs, 99: 1-432	[Not domesticated] "In Africa found disjunctly in South Africa and in northern Africa around the Mediterranean; naturalized in disturbed, often coastal, habitats worldwide; sand dunes, grass, forest margins, river banks, and roadsides at 0-1200 m elevation."

102	**Has the species become naturalized where grown?**	
	Source(s)	**Notes**
	WRA Specialist. (2022). Personal Communication	NA

103	**Does the species have weedy races?**	
	Source(s)	**Notes**
	WRA Specialist. (2022). 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"**	**High**
	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 Africa, now widely established in warm temperate areas, often in sub-maritime situations"
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/. [Accessed 25 Aug 2022]	"Native Africa SOUTH TROPICAL AFRICA: Mozambique, Zimbabwe SOUTHERN AFRICA: South Africa [Eastern Cape, Western Cape]"

202	**Quality of climate match data**	**High**
	Source(s)	**Notes**
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/. [Accessed 25 Aug 2022]	

203	**Broad climate suitability (environmental versatility)**	**y**
	Source(s)	**Notes**

Qsn #	Question	Answer
	Vorontsova, M. S., & Knapp, S. (2016). A Revision of the" Spiny Solanums," Solanum Subgenus Leptostemonum (Solanaceae), in Africa and Madagascar. Systematic Botany Monographs, 99: 1-432	"In Africa found disjunctly in South Africa and in northern Africa around the Mediterranean; naturalized in disturbed, often coastal, habitats worldwide; sand dunes, grass, forest margins, river banks, and roadsides at 0-1200 m elevation."
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Subhumid and humid warm-temperate regions, growing well on the sandy calcareous soils of coastal areas where it competes strongly with native species and poorer pastures."
	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.	[Temperate to sub-tropical climates] "Native to Africa, now widely established in warm temperate areas, often in sub-maritime situations; in Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest, up to 575 m"

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	**Notes**
	Vorontsova, M. S., & Knapp, S. (2016). A Revision of the" Spiny Solanums," Solanum Subgenus Leptostemonum (Solanaceae), in Africa and Madagascar. Systematic Botany Monographs, 99: 1-432	"In Africa found disjunctly in South Africa and in northern Africa around the Mediterranean; naturalized in disturbed, often coastal, habitats worldwide; sand dunes, grass, forest margins, river banks, and roadsides at 0-1200 m elevation."
	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 Africa, now widely established in warm temperate areas, often in sub-maritime situations; in Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest, up to 575 m, on O'ahu, Moloka' i, Lana'i, Maui, and Hawai'i. First collected on O'ahu in 1895 (Heller 2409, F, GH, MO, NY, UC)."

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	**Notes**
	Vorontsova, M. S., & Knapp, S. (2016). A Revision of the" Spiny Solanums," Solanum Subgenus Leptostemonum (Solanaceae), in Africa and Madagascar. Systematic Botany Monographs, 99: 1-432	"naturalized in disturbed, often coastal, habitats worldwide"

301	Naturalized beyond native range	y
	Source(s)	**Notes**
	Vorontsova, M. S., & Knapp, S. (2016). A Revision of the" Spiny Solanums," Solanum Subgenus Leptostemonum (Solanaceae), in Africa and Madagascar. Systematic Botany Monographs, 99: 1-432	"In Africa found disjunctly in South Africa and in northern Africa around the Mediterranean; naturalized in disturbed, often coastal, habitats worldwide; sand dunes, grass, forest margins, river banks, and roadsides at 0-1200 m elevation."
	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 Africa, now widely established in warm temperate areas, often in sub-maritime situations; in Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest, up to 575 m, on O'ahu, Moloka' i, Lana'i, Maui, and Hawai'i. First collected on O'ahu in 1895 (Heller 2409, F, GH, MO, NY, UC)."

Qsn #	Question	Answer
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/. [Accessed 25 Aug 2022]	"Naturalized Africa MACARONESIA: Portugal [Azores, Madeira Islands] NORTHEAST TROPICAL AFRICA: Eritrea Australasia AUSTRALIA: Australia NEW ZEALAND: New Zealand Europe SOUTHEASTERN EUROPE: Albania, Bulgaria, Greece, Croatia, Italy (incl. Sardinia, Sicily) SOUTHWESTERN EUROPE: Spain (incl. Baleares), France [Corse], Portugal Pacific NORTH-CENTRAL PACIFIC: United States [Hawaii] SOUTHWESTERN PACIFIC: Fiji, New Caledonia"
	Herbarium Pacificum Staff. (1998). New Hawaiian plant records for 1997. Bishop Museum Occasional Papers. 56:8 -14	"Solanum linnaeanum Hepper & P. Jaeger New island record Previously recorded as naturalized from Oʻahu, Molokaʻi, Länaʻi, Maui, and Hawaiʻi (Wagner et al., 1990), apple of Sodom is now also recorded from Kahoʻolawe. Material examined: KAHOʻOLAWE: E slope of Moaʻula, 1350 ft., 25 Apr 1980, G. Clarke & C. Corn 414."

302	Garden/amenity/disturbance 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 Hawaiʻi Press and Bishop Museum Press, Honolulu, HI.	[A weed of disturbed, and dry forest habitats that may interfere with restoration of degraded dry forest ecosystems] "in Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest, up to 575 m"

Qsn #	Question	Answer
303	**Agricultural/forestry/horticultural weed**	**y**
	Source(s)	**Notes**
	Haselwood, E.L., Motter, G.G., & Hirano, R.T. (eds.). (1983) Handbook of Hawaiian Weeds. University of Hawaii Press, Honolulu, HI	"Common in dry lowlands. A weed in postures, rangelands, and waste places."
	HerbiGuide. (2022). Apple-of-Sodom. http://www.herbiguide.com.au/descriptions/hg_appleofsodom.htm. [Accessed 30 Aug 2022]	"Detrimental: Weed of grazed woodlands, streams, roadsides and disturbed areas. Competes strongly with native species. Crowds pasture species because it is not grazed. Restrict stock and human movement. Harbours rabbits and snails."
	Motooka, P., Castro, L., Nelson, D., Nagai, G. & Ching,L. (2003). Weeds of Hawaii's Pastures and Natural Areas: An Identification and Management Guide. CTAHR, UH Manoa, Honolulu, HI	"Infests dry pastures and forests, displacing other plants and hindering movement of people and animals"
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Impacts pastures and can contribute to environmental problems] "The foliage is not eaten by stock because of its prickly nature and so infestations are usually free to develop unchecked. This can result in dense patches which crowd out other vegetation, restrict stock movement and provide harbour for rabbits. In coastal areas, the plants also harbour a large number of snails"

304	**Environmental weed**	**y**
	Source(s)	**Notes**
	Queensland Government. (2022). Weeds of Australia. Solanum linnaeanum. https://keyserver.lucidcentral.org/weeds/. [Accessed 29 Aug 2022]	"Apple of Sodom (Solanum linnaeanum) is regarded as an environmental weed in Victoria and Western Australia. It was also recently listed as a priority environmental weed in two Natural Resource Management regions."
	Weber, E. (2017). Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Where invasive the shrub forms dense thickets and strongly competes with native plants and may restrict water access to livestock and wildlife."
	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.	[A weed of disturbed, and dry forest habitats that may interfere with restoration of degraded dry forest ecosystems] "in Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest, up to 575 m"
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Impacts pastures and can contribute to environmental problems] "The foliage is not eaten by stock because of its prickly nature and so infestations are usually free to develop unchecked. This can result in dense patches which crowd out other vegetation, restrict stock movement and provide harbour for rabbits. In coastal areas, the plants also harbour a large number of snails"

305	**Congeneric weed**	**y**
	Source(s)	**Notes**
	USDA NRCS. (2022). Introduced, Invasive, and Noxious Plants. https://plantsorig.sc.egov.usda.gov/java/noxiousDriver. [Accessed 29 Aug 2022]	Hawaii State-listed Noxious Weeds include: Solanum carolinense L., Solanum elaeagnifolium Cav., Solanum robustum Wendl. & Solanum torvum Sw. Federal noxious weeds include: Solanum tampicense, Solanum torvum & Solanum viarum

Qsn #	Question	Answer
	Weber, E. (2017). Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	Solanum laxum. Solanum linnaeanum, Solanum mauritianum, Solanum nigrum, Solanum tampicense, Solanum viarum listed as weeds of natural areas

401	Produces spines, thorns or burrs	y
	Source(s)	**Notes**
	Haselwood, E.L., Motter, G.G., & Hirano, R.T. (eds.). (1983) Handbook of Hawaiian Weeds. University of Hawaii Press, Honolulu, HI	"A pest with sharp spines on leaves and stems, known to be poisonous."
	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.	"Shrubs up to 1 m tall and in diameter, most parts armed with prominent, stout, nearly straight, straw-colored prickles up to 15 mm long, pubescent with stellate hairs, sparse on upper leaf surface, dense on lower surface, and also with minute, simple, glandular hairs."

402	Allelopathic	
	Source(s)	**Notes**
	Garzoli, S., Orlando, F., Iriti, M., & Vitalini, S. (2022). Solanum linnaeanum Leaves: Chemical Profiling of VOCs and Effects on Seed Germination and Early Growth of Monocots and Dicots. Chemistry & Biodiversity, 19(4), e202100975	[Extracts demonstrate allelopathic properties] "Some Solanaceae plants are a rich source of sesquiterpenoid phytoalexins with allelopathic potential. Powder and aqueous extract obtained from the leaves of Solanum linnaeanum Hepper & P.M.L. Jaeger were used to treat the seeds of three target species (Lolium multiflorum Lam., Sinapis alba L. and Trifolium incarnatum L.). Both matrices were evaluated along with untreated controls to determine their toxicity on germination and seedling growth. The results revealed that the pre-emergence treatments were able to be very effective against all three species in the filter paper test by inhibiting the germination up to 100%. The effectiveness was reduced by the interaction with soil. Despite this, significant data were obtained, albeit different according to the applied matrix. In general, L. multiflorum was the most sensitive to both the action of the leaf powder and aqueous extract while S. alba was found to be the most resistant to powder activity and T. incarnatum had the strongest response to the extract. For the first time, SPME-GC/MS technique was used to characterize the volatile chemical profile of S. linnaeanum leaves. The analyses highlighted the presence of different classes of compounds including terpenoids and sesquiterpenoids potentially useful in the fight against noxious plants both in natural and cultivated ecosystems."

403	Parasitic	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.	"Shrubs up to 1 m tall and in diameter, most parts armed with prominent, stout, nearly straight, straw-colored prickles up to 15 mm long, pubescent with stellate hairs, sparse on upper leaf surface, dense on lower surface, and also with minute, simple, glandular hairs." [Solanaceae. No evidence]

Qsn #	Question	Answer
404	**Unpalatable to grazing animals**	**y**
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"The foliage is not eaten by stock because of its prickly nature and so infestations are usually free to develop unchecked."

405	**Toxic to animals**	**y**
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	[Toxic but avoided by animals] "The fruit is poisonous due to the presence of glyco-alkaloids including solasonine, solasodine and solasodamine but has not been a problem in Australia because it is not consumed-by animals or humans. The foliage is not eaten by stock because of its prickly nature and so infestations are usually free to develop unchecked."

406	**Host for recognized pests and pathogens**	
	Source(s)	**Notes**
	CABI. (2022). Bactrocera latifrons (Solanum fruit fly). https://www.cabi.org/isc/datasheet/8719. [Accessed 30 Aug 2022]	"This is a pest of solanaceous crops throughout its range" [Solanum linnaeanum one of many hosts of this pest]

407	**Causes allergies or is otherwise toxic to humans**	**y**
	Source(s)	**Notes**
	Haselwood, E.L., Motter, G.G., & Hirano, R.T. (eds.). (1983) Handbook of Hawaiian Weeds. University of Hawaii Press, Honolulu, HI	"A pest with sharp spines on leaves and stems, known to be poisonous."
	Wheeler, J.R., Marchant, N.G.& Lewington, M. (2002). Flora of the South West: Bunbury, Augusta, Denmark, Volume 2. UWA Publishing, Crawley, Western Australia	"Note: Declared noxious weed. Toxic to children and stock."
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"The fruit is poisonous due to the presence of glyco-alkaloids including solasonine, solasodine and solasodamine but has not been a problem in Australia because it is not consumed-by animals or humans."
	McKenzie, R. (2020). Australia's Poisonous Plants, Fungi and Cyanobacteria: A Guide to Species of Medical and Veterinary Importance. CSIRO Publishing, Clayton South, VIC	[Solanum linnaeanum] "Animals at risk - Herbivores, humans (eating fruit)" ... "Syndrome - Enzootic calcinosis – deposits of mineral (calcium) in soft tissues of the body cause weight loss and lameness after prolonged intake of the plant"

408	**Creates a fire hazard in natural ecosystems**	**n**
	Source(s)	**Notes**
	Victorian Resources Online. (2020). Impact Assessment - Apple of Sodom (Solanum linnaeanum) in Victoria. https://vro.agriculture.vic.gov.au/dpi/vro/vrosite.nsf/pages/impact_apple_sodom. [Accessed 30 Aug 2022]	"Predominantly evergreen (plants are partially deciduous), it does not significantly increase fuel load. It therefore presents little change to the fire regime."

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.	[May contribute to fuel load in dry, fire prone habitats, but not likely to increase fire risk relative to invasive grasses and other fine fuels prevalent in degraded dry forest ecosystems] "in Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest"

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	**Notes**
	Plantsbank. (2022). Solanum linnaeanum. https://plantsbank.com/solanum-linnaeanum/. [Accessed 30 Aug 2022]	"Sun Exposure: full sun"
	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.	[Occurs in open, high light environments] "in Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest"

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"growing well on the sandy calcareous soils of coastal areas where it competes strongly with native species and poorer pastures."
	HerbiGuide. (2022). Apple-of-Sodom. http://www.herbiguide.com.au/descriptions/hg_appleofsodom.htm. [Accessed]	"Soil: Sandy alkaline soils especially near the coast. Basalt soils."
	Plantsbank. (2022). Solanum linnaeanum. https://plantsbank.com/solanum-linnaeanum/. [Accessed 30 Aug 2022]	Soil pH: Alkaline, Neutral Soil Moisture: Dry, Moist Soil Type: Sandy, Silty, Clayey, Stony

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.	"Shrubs up to 1 m tall and in diameter, most parts armed with prominent, stout, nearly straight, straw-colored prickles up to 15 mm long"

412	Forms dense thickets	y
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"The foliage is not eaten by stock because of its prickly nature and so infestations are usually free to develop unchecked. This can result in dense patches which crowd out other vegetation, restrict stock movement and provide harbour for rabbits."
	Weber, E. (2017). Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Where invasive the shrub forms dense thickets and strongly competes with native plants and may restrict water access to livestock and wildlife."

Qsn #	Question	Answer
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] "In Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest, up to 575 m"

502	Grass	n
	Source(s)	**Notes**
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/. [Accessed 25 Aug 2022]	Genus: Solanum Subgenus: Leptostemonum Section: Melongena Family: Solanaceae Subfamily: Solanoideae Tribe: Solaneae

503	Nitrogen fixing woody plant	n
	Source(s)	**Notes**
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/. [Accessed 25 Aug 2022]	Genus: Solanum Subgenus: Leptostemonum Section: Melongena Family: Solanaceae Subfamily: Solanoideae Tribe: Solaneae

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	**Notes**
	Vorontsova, M. S., & Knapp, S. (2016). A Revision of the" Spiny Solanums," Solanum Subgenus Leptostemonum (Solanaceae), in Africa and Madagascar. Systematic Botany Monographs, 99: 1-432	"Erect shrub, 0.4-1.5 m, prickly. Young stems terete, glabrous to moderately stellate-pubescent, prickly, the stellate trichomes porrect, sessile or stalked, the stalks to 0.2 mm long, the rays 5-8 (-15), 0.1-0.4 mm long, the midpoints 0.1-0.5 mm long, the prickles 3-7 mm long, (0.7-) 1.5-2 mm wide at base, straight, narrow-deltate, flattened, pale yellow-orange, glabrous, spaced 3-10 mm apart; bark of older stems glabrescent, pale orange-brown or darker green-brown."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	**Notes**
	Vorontsova, M. S., & Knapp, S. (2016). A Revision of the" Spiny Solanums," Solanum Subgenus Leptostemonum (Solanaceae), in Africa and Madagascar. Systematic Botany Monographs, 99: 1-432	[No evidence] "In Africa found disjunctly in South Africa and in northern Africa around the Mediterranean; naturalized in disturbed, often coastal, habitats worldwide; sand dunes, grass, forest margins, river banks, and roadsides at 0-1200 m elevation."

602	Produces viable seed	y

Qsn #	Question	Answer
	Source(s)	**Notes**
	Weber, E. (2017). Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Apple of Sodom reproduces by seeds, which do not have particular mechanisms for dispersal. Fruits drop off and are blown or dragged away with the seeds enclosed."
	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.	"Berries yellow at maturity, dark brown upon drying, firm, mucilaginous, globose, 2-3 cm in diameter, fruiting pedicels thickened and recurved, calyx somewhat enlarged, all parts very prickly. Seeds numerous, pale brown, rounded or obovate, biconvex, 2-3 mm long, testa minutely reticulate."
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Seeds germinate in spring and seedlings develop slowly in the early months, plants generally not flowering until at least 2 years old. Flowering and fruiting of established plants extends from late spring to the end of summer. Plants are partially deciduous in winter. Germination is enhanced where the adult plants are removed."

603	**Hybridizes naturally**	
	Source(s)	**Notes**
	Plazas, M. et al. (2016). Interspecific hybridization between eggplant and wild relatives from different genepools. Journal of the American Society for Horticultural Science, 141(1), 34-44	[Interspecific hybrids possible. Unknown if natural hybridization occurs] "No germination was obtained in the hybrids with S. linnaeanum when using S. melongena as maternal parent, whereas good germination was obtained in the reciprocal cross. Other researchers have also reported the use of S. linnaeanum as maternal parent to obtain interspecific hybrid plants with S. melongena (Acciarri et al., 2007; Doganlar et al., 2002; Liu et al., 2015). It remains to be investigated if this phenomenon is due to embryo or endosperm failure in specific hybrid combinations, as it has been found in other eggplant crosses (Lester and Kang, 1998), or due to other causes. Therefore, we recommend using S. linnaeanum as a female parent in interspecific hybridizations with eggplant."

604	**Self-compatible or apomictic**	**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.	"Self-compatible"

605	**Requires specialist pollinators**	**n**
	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.	"Lower flowers perfect, upper ones staminate, actinomorphic, few to 6 in stout racemose cymes from an internodal position, lower flower sometimes solitary, peduncles short or absent, pedicels ca. 1 cm long, prickly; calyx densely prickly, the tube ca. 5 mm long, the lobes triangular, 2-3 mm long; corolla purplish blue, rotate-stellate, ca. 2 cm in diameter, the lobes acute; stamens inserted near base of corolla tube; filaments 1-2 mm long; anthers erect, tapered above, 5 -6 mm long, opening by terminal pores; ovary glabrous or with a few glandular hairs, vestigial in staminate flowers; style up to 1 cm long, sparsely pubescent in lower part, vestigial in staminate flowers; stigma green, capitate." ... "Self-compatible"
	Ramsay, G., & Bryan, G. (2011). Solanum. In Wild Crop Relatives: Genomic and Breeding Resources (pp. 259-271). Springer, Berlin, Heidelberg	[Generic description] "Solanum species are generally pollinated by bees. Flowers are pentamerous and usually radially symmetrical but sometimes zygomorphic and without floral nectaries, thus providing only a pollen reward for pollinators."

606	Reproduction by vegetative fragmentation	n
	Source(s)	**Notes**
	Queensland Government. (2022). Weeds of Australia. Solanum linnaeanum. https://keyserver.lucidcentral.org/weeds/. [Accessed 30 Aug 2022]	"This species reproduces only by seed. These seeds are usually not spread very far from the parent plants, but the fruit may be dragged significant distances when the prickly stems become attached to animals or machinery."

607	Minimum generative time (years)	2
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Seeds germinate in spring and seedlings develop slowly in the early months, plants generally not flowering until at least 2 years old."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	**Notes**
	Department of Primary Industries. (2010). Solanum linnaeanum Regionally Prohibited Weeds Information Sheet. The State of Victoria. https://www.vgls.vic.gov.au. [Accessed 29 Aug 2022]	"The fruit ripens on the bush eventually dropping off and is blown or dragged away with the seeds enclosed. The weed is commonly found along fence lines, raised outcrops, dunes and established vegetation where the fruit comes to rest."
	Queensland Government. (2022). Weeds of Australia. Solanum linnaeanum. https://keyserver.lucidcentral.org/weeds/. [Accessed 30 Aug 2022]	"This species reproduces only by seed. These seeds are usually not spread very far from the parent plants, but the fruit may be dragged significant distances when the prickly stems become attached to animals or machinery."
	Department of Primary Industries and Regional Development's Agriculture and Food. (2022). Apple of Sodom: declared pest. https://www.agric.wa.gov.au/declared-plants/apple-sodom-declared-pest. [Accessed 29 Aug 2022]	"Where to find it: apple of Sodom prefers calcareous sands but is not confined to them. It could be in a pasture (particularly if over-grazed), on roadsides, waste land or other disturbed soils. It is sometimes found where roadworks have been carried out and limestone used as part of the roadbase." [Dispersed along roadsides, probably as a soil contaminant]

Qsn #	Question	Answer
702	**Propagules dispersed intentionally by people**	**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.	[Unlikely. A weed of pastures with no current evidence of cultivation or intentional introduction] "Native to Africa, now widely established in warm temperate areas, often in sub-maritime situations; in Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest, up to 575 m, on O'ahu, Moloka' i, Lana'i, Maui, and Hawai'i. First collected on O'ahu in 1895"

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, Herbal, Ornamental Dispersed by: Humans, Animals Weed of: Pastures"
	WRA Specialist. (2022). Personal Communication	Could possibly be dispersed as a seed contaminant of hay or silage from infested pastures.

704	**Propagules adapted to wind dispersal**	
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"The fruit ripens on the bush, eventually dropping off, and is blown or dragged away with the seeds enclosed." [No specific adaptations for wind dispersal, but wind may influence distance and direction of fruit drop]

705	**Propagules water dispersed**	**y**
	Source(s)	**Notes**
	HerbiGuide. (2022). Apple-of-Sodom. http://www.herbiguide.com.au/descriptions/hg_appleofsodom.htm. [Accessed 30 Aug 2022]	"Spread by seed. As the fruit is not attractive to animals or birds it is assumed that spread is by water or soil movement. The seed remains within the fruit, which ripens on the bush and eventually falls."
	Vorontsova, M. S., & Knapp, S. (2016). A Revision of the" Spiny Solanums," Solanum Subgenus Leptostemonum (Solanaceae), in Africa and Madagascar. Systematic Botany Monographs, 99: 1-432	[Plants occurring along rivers likely dispersed by water] "naturalized in disturbed, often coastal, habitats worldwide; sand dunes, grass, forest margins, river banks, and roadsides at 0-1200 m elevation."

706	**Propagules bird dispersed**	**n**
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Apple of Sodom is spread by seed but dispersal is not as effective as with many other Solanum species because neither the fruit nor seeds are eaten by birds or animals. The fruit ripens on the bush, eventually dropping off, and is blown or dragged away with the seeds enclosed."

707	**Propagules dispersed by other animals (externally)**	**y**

Qsn #	Question	Answer
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Apple of Sodom is spread by seed but dispersal is not as effective as with many other Solanum species because neither the fruit nor seeds are eaten by birds or animals. The fruit ripens on the bush, eventually dropping off, and is blown or dragged away with the seeds enclosed."
	Queensland Government. (2022). Weeds of Australia. Solanum linnaeanum. https://keyserver.lucidcentral.org/weeds/. [Accessed]	"This species reproduces only by seed. These seeds are usually not spread very far from the parent plants, but the fruit may be dragged significant distances when the prickly stems become attached to animals or machinery."

708	**Propagules survive passage through the gut**	**n**
	Source(s)	**Notes**
	Parsons, W.T. & Cuthbertson, E.G. (2001). Noxious Weeds of Australia. Second Edition. CSIRO Publishing, Collingwood, Australia	"Apple of Sodom is spread by seed but dispersal is not as effective as with many other Solanum species because neither the fruit nor seeds are eaten by birds or animals. The fruit ripens on the bush, eventually dropping off, and is blown or dragged away with the seeds enclosed."

801	**Prolific seed production (>1000/m2)**	
	Source(s)	**Notes**
	Western Australian Herbarium (1998–2022). FloraBase—the Western Australian Flora. Department of Parks and Wildlife. https://florabase.dpaw.wa.gov.au/. [Accessed 30 Aug 2022]	"This species reproduces only by seed. Produces approximately 300 berries per plant with 50 seeds per berry resulting in 1,500 seeds per plant." [Soil densities unspecified]

802	**Evidence that a persistent propagule bank is formed (>1 yr)**	**y**
	Source(s)	**Notes**
	Department of Primary Industries and Regional Development's Agriculture and Food. (2022). Apple of Sodom: declared pest. https://www.agric.wa.gov.au/declared-plants/apple-sodom-declared-pest. [Accessed 29 Aug 2022]	"Seeds: most of the seed germinates in spring and late summer. Some seed may remain dormant in the soil for several years. Germination is greatly increased when the adult plant is removed."
	Western Australian Herbarium (1998–2022). FloraBase—the Western Australian Flora. Department of Parks and Wildlife. https://florabase.dpaw.wa.gov.au/. [Accessed 30 Aug 2022]	[1-2 years] "Seedbank persistence. Persistence unknown most seed appears to germinate within a year or two of production."

803	**Well controlled by herbicides**	**y**
	Source(s)	**Notes**
	Motooka, P., Castro, L., Nelson, D., Nagai, G. & Ching,L. (2003). Weeds of Hawaii's Pastures and Natural Areas: An Identification and Management Guide. CTAHR, UH Manoa, Honolulu, HI	"Management: Sensitive to foliar-applied dicamba. Susceptible to soil-applied tebuthiuron at 2 lb/acre (48). Goats control apple-of-Sodom (An Peischel). Seedlings are easily killed by cultivation or pulling (61)."

Qsn #	Question	Answer
	Department of Primary Industries and Regional Development's Agriculture and Food. (2022). Apple of Sodom control. https://www.agric.wa.gov.au/herbicides/apple-sodom-control. [Accessed 30 Aug 2022]	"Recommended herbicides Amitrole T® Triclopyr Glyphosate Picloram + 2,4-D amine" [Notes on efficacy, application methods, and rates of application are detailed on the website]

804	**Tolerates, or benefits from, mutilation, cultivation, or fire**	
	Source(s)	**Notes**
	Auckland Council. (2022). Solanum linnaeanum - Apple of Sodom. https://www.tiakitamakimakaurau.nz/protect-and-restore-our-environment/pests-in-auckland/pest-search/sollin/. [Accessed 30 Aug 2022]	"Physical control Method: Dig out. Plant parts requiring disposal: Seeds if practical. Disposal options: Can be left on-site to rot down but check for regrowth."
	HerbiGuide. (2022). Apple-of-Sodom. http://www.herbiguide.com.au/descriptions/hg_appleofsodom.htm. [Accessed 30 Aug 2022]	[Possibly. May require herbicide treatment to prevent regrowth following cutting] "Manually remove and burn isolated plants. Apply a mixture of 120 mL amitrole(250g/L) in 10 L water and spray the bush until thoroughly wet. Seedlings and young plants can also be hand pulled with gloves. Cultivation, followed by treatment of regrowth and seedlings with Tordon® 75-D, is effective."

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. Does not appear to be limited by natural enemies] "Native to Africa, now widely established in warm temperate areas, often in sub-maritime situations; in Hawai'i naturalized in dry pastures, coastal to dry shrubland and dry forest, up to 575 m, on O'ahu, Moloka' i, Lana'i, Maui, and Hawai'i. First collected on O'ahu in 1895"

Summary of Risk Traits:

High Risk / Undesirable Traits
Broad climate suitability
Native to and naturalized in regions with temperate to tropical climates
Naturalized on Oahu, Molokai, Lanai, Maui, Kahoolawe, and Hawaii (Hawaiian Islands) and widely naturalized elsewhere
In Hawaii, a weed of dry pastures, coastal to dry shrubland and dry forest
An agricultural weed of pastures, displacing other plants and hindering movement of people and animals
An environmental weed in Australia, competing with native plants and harboring invasive species like rabbits
A potential environmental weed in the Hawaiian Islands
Other Solanum species are invasive weeds
Armed with prominent, stout, nearly straight, straw-colored prickles
Possibly allelopathic
Toxic to animals and people (but rarely, if ever, consumed)
Unpalatable to grazing animals (due to prickles)
Forms dense thickets
Reproduces by seeds
Self-fertile
Reaches maturity in 2 years
Fruits not consumed by birds or other animals, but fruit and seeds may be dispersed by attaching to machinery and animals, soil movement, water, and potentially as a contaminant
Prolific seed production (ca. 1500/plant)
Seeds may persist in the soil for 1 to 2 or more years
May resprout without herbicide treatment

Low Risk Traits
Grows best in high light environments (dense shade may inhibit spread)
Herbicides may provide effective control