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Taxon: Anthoxanthum odoratum L.	Family: Poaceae
Common Name(s): scented vernal grass sweet vernal grass sweet-scent vernal grass	Synonym(s): Anthoxanthum odoratum var. Anthoxanthum pilosum Döll Anthoxanthum villosum Dumort. Xanthonanthos odoratum (L.) St.-Lag.

Assessor: No Assessor	Status: Assessor Approved	End Date: 16 May 2018
WRA Score: 14.0	Designation: H(Hawai'i)	Rating: High Risk

Keywords: Perennial Grass, Environmental Weed, Allergen, Dense Mats, Wind-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)	Low
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		
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
402	Allelopathic	y=1, n=0	y
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	y
408	Creates a fire hazard in natural ecosystems	y=1, n=0	y

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Qsn #	Question	Answer Option	Answer
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	y
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	n
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	n
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	1
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	y
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	y
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed		
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)		
708	Propagules survive passage through the gut	y=1, n=-1	y
801	Prolific seed production (>1000/m2)	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		
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
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[No evidence] "yields essential aromatic oil, reproduces by seeds dispersed by wind, fodder grass, forage, cultivated in hay fields and widely naturalized in temperate regions, not palatable, little food value, weed and aggressive species but is not considered a major weed pest, very resistant to cold and heat, good resistance to drought"

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. 2018. Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. 2018. 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"	Low
	Source(s)	Notes
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"Europe, temperate Asia, northwest Africa."
	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 Eurasia and now widely naturalized in temperate North America"

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Qsn #	Question	Answer
	<p>USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 16 May 2018]</p>	<p>"Native Africa MACARONESIA: Portugal, [Madeira Islands] Spain [Canary Islands] NORTHERN AFRICA: Algeria, Morocco, Tunisia Asia-Temperate WESTERN ASIA: Iran (n.w.), Lebanon, Syria, Turkey CAUCASUS: Armenia, Azerbaijan, Georgia, Russian Federation-Ciscaucasia [Ciscaucasia] SIBERIA: Russian Federation-Eastern Siberia, [Eastern Siberia] Russian Federation-Western Siberia [Western Siberia] MIDDLE ASIA: Kazakhstan, Kyrgyzstan MONGOLIA: Mongolia CHINA: China [Heilongjiang, Jilin, Liaoning, Xinjiang] EASTERN ASIA: Japan, Korea Europe NORTHERN EUROPE: Denmark, Faroe Islands, Finland, Iceland, Ireland, Norway, Sweden, United Kingdom MIDDLE EUROPE: Austria, Belgium, Czech Republic, Germany, Hungary, Netherlands, Poland, Slovakia, Switzerland EASTERN EUROPE: Belarus, Estonia, Latvia, Lithuania, Moldova, Russian Federation-European part, [European part] Ukraine (incl. Krym) SOUTHEASTERN EUROPE: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece (incl. Crete), Italy (incl. Sardinia, Sicily), Montenegro, Romania, Serbia, Slovenia SOUTHWESTERN EUROPE: France (incl. Corsica), Portugal, Spain (incl. Balears)"</p>

202	Quality of climate match data	High
	Source(s)	Notes
	<p>USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 16 May 2018]</p>	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	<p>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.</p>	<p>"in Hawai'i naturalized in pastures, disturbed areas in wet forest, and sometimes subalpine shrubland, 840-2,140 m" [Elevation range exceeds 1000 m, demonstrating environmental versatility]</p>

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Qsn #	Question	Answer
	Dave's Garden. 2018. Sweet Vernal Grass, Vanilla Grass - <i>Anthoxanthum odoratum</i> . https://davesgarden.com/guides/pf/go/32276/ . [Accessed 16 May 2018]	'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) USDA Zone 9a: to -6.6 °C (20 °F) USDA Zone 9b: to -3.8 °C (25 °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.	"in Hawai'i naturalized in pastures, disturbed areas in wet forest, and sometimes subalpine shrubland, 840-2,140 m, on Moloka'i, Maui, and Hawai'i." [Naturalized in upper elevations, which are more similar to temperate climates, but lower elevations are subtropical]

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Africa, Asia, Australia, New Zealand, North America, South America, Mascarenes, Micronesia, Hawaiian Islands"

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Qsn #	Question	Answer
	<p>USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 16 May 2018]</p>	<p>"Cultivated Asia-Tropical INDIAN SUBCONTINENT: India Europe MIDDLE EUROPE: Austria Northern America United States Naturalized Africa MACARONESIA: Portugal [Azores] SOUTHERN AFRICA: South Africa WESTERN INDIAN OCEAN: Mauritius, Reunion Australasia AUSTRALIA: Australia NEW ZEALAND: New Zealand Northern America United States (w.) Pacific NORTH-CENTRAL PACIFIC: United States [Hawaii] NORTHWESTERN PACIFIC: Micronesia Southern America CENTRAL AMERICA: Central America South America"</p>

301	Naturalized beyond native range	y
	Source(s)	Notes
	<p>Snow, N., & Davidse, G. 2011. Notes on grasses (Poaceae) in Hawai'i:3. Bishop Museum Occasional Papers. 110:11-22</p>	<p>"<i>Anthoxanthum odoratum</i> L. New island record this perennial species, which is known by the common name vernalgrass, occurs naturally in southern Europe but has become widespread elsewhere (Allred & Barkworth 2007). of potential concern in Hawai'i is the aggressive weedy tendency the species has shown along the coast of British Columbia, Canada, where it is said to be rapidly invading moss-covered bedrock of coastal bluffs, evidently to the exclusion of native species (Allred & Barkworth 2007). the species has been recorded previously on Kaua'i, Moloka'i, Maui, and Hawai'i (Imada 2008). Material examined. O'AHU: Mt Ka'ala road, west mesic roadside, without date, US Army 123 (BISH 738557)."</p>
	<p>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.</p>	<p>"Native to Eurasia and now widely naturalized in temperate North America; in Hawai'i naturalized in pastures, disturbed areas in wet forest, and sometimes subalpine shrubland, 840-2,140 m, on Moloka'i, Maui, and Hawai'i."</p>
	<p>Edgar, E. & Connor, H. 2000. Flora of New Zealand, vol. V: Gramineae. Manaaki Whenua Press, Lincoln, New Zealand</p>	<p>"Naturalised. N.; S.: throughout; St.; K., Ch., A., C. Roadsides, waste land, pasture and tussock grassland, in scrub or forest clearings, sometimes in boggy, or sandy or rocky, stony ground; sea level to subalpine."</p>

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Qsn #	Question	Answer
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 16 May 2018]	"Naturalized Africa MACARONESIA: Portugal [Azores] SOUTHERN AFRICA: South Africa WESTERN INDIAN OCEAN: Mauritius, Reunion Australasia AUSTRALIA: Australia NEW ZEALAND: New Zealand Northern America United States (w.) Pacific NORTH-CENTRAL PACIFIC: United States [Hawaii] NORTHWESTERN PACIFIC: Micronesia Southern America CENTRAL AMERICA: Central America South America"

302	Garden/amenity/disturbance weed	
	Source(s)	Notes
	WRA Specialist. 2018. Personal Communication	A disturbance weed with environmental impacts [See 3.04]

303	Agricultural/forestry/horticultural weed	
	Source(s)	Notes
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"invades disturbed areas, found in mixed pastures and meadows, open fields, along roadsides, waste places, woods,"
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Weed of: Cereals, Pastures, Vegetables" [Potential crop weed]

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Qsn #	Question	Answer
304	Environmental weed	y
	Source(s)	Notes
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Coastal dunes, grass- and heathland, forests, freshwater wetlands, riparian habitats...The species is highly competitive to other grass species because it grows rapidly and flowers earlier than native species...The herbicide dalapon has proved to be effective for control of this grass."
	Loope, L.L., Nagata, R.J. & Medeiros, A.C. 1992, Alien plants in Haleakala National Park Pp. 551-576 in Stone et al (eds) Alien plant invasions in native ecosystems of Hawaii. Coop. Nat. Park Resources Studies Unit, University of Hawaii, Honolulu, HI	"The subalpine shrubland has been modified by years of impact of goats, cattle, and pigs. The often dense mat of alien grasses such as velvet grass (<i>Holcus lanatus</i>), sweet vernalgrass (<i>Anthoxanthum odoratum</i>), and orchard grass (<i>Dactylis glomerata</i>) inhibits reproduction by seed of native shrubs."
	Smith, C.W. 1985. Impact of Alien Plants on Hawaii's Native Biota. Pp. 180-250 in Stone & Scott (eds.). Hawaii's terrestrial ecosystems: preservation & management. CPSU, Honolulu, HI	"This small, perennial bunchgrass forms extensive ground cover in open mesic and dry habitats at high elevations, It invades disturbed areas, preventing the reestablishment of native species, The seeds are dispersed by wind, Its cover increases after fire, but this increase appears to be the result of reduced competition rather than stimulation. It has not been evaluated for biological control, It occurs between 1,500-3,000 m on Haleakala, Maui, and Mauna Kea and Mauna Loa, Hawai'i. some scrubland habitats on Haleakala have almost pure stands of this grass between the bushes."

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>Anthoxanthum aristatum</i> ... Dispersed by: Humans, Animals, Water, Wind, Escapee ... Weed of: Cereals"
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	" <i>Anthoxanthum aristatum</i> ...cultivated and occasionally escaped weed species of cultivated and wasteland, disturbed sites, in open habitats"

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] "Slender perennials, forming small tufts; culms erect or spreading, 30-60 cm long, ca. 1 mm in diameter, hollow, glabrous, nodes darker than internodes, glabrous. Sheaths 3 -8 cm long, striate, shorter than internodes, glabrous or with weak retrorse hairs, ciliate at throat; ligule conspicuous, sometimes purple, membranous, 1.5-4 mm long; blades 5-20 cm long, 2-7 mm wide, glabrous or with scattered weak, soft hairs, conspicuously auriculate."

402	Allelopathic	y
	Source(s)	Notes

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Qsn #	Question	Answer
	<p>Yamamoto, Y. (1995). Allelopathic potential of <i>Anthoxanthum odoratum</i> for invading <i>Zoysia</i>-grassland in Japan. <i>Journal of Chemical Ecology</i>, 21(9), 1365-1373</p>	<p>"Abstract The growth of <i>Zoysia japonica</i> surrounding <i>Anthoxanthum odoratum</i> on <i>Zoysia</i> grassland in Japan was investigated in June 1994. The stem density of <i>Z. japonica</i> tended to decrease with short distances between two <i>A. odoratum</i> plants. This showed that the growth of <i>Z. japonica</i> surrounding <i>A. odoratum</i> was reduced. Basic, neutral, and acidic fractions extracted from <i>A. odoratum</i> plants inhibited the seedling growth of lettuce. In particular the neutral fraction showed the strongest activity among the three fractions. The main inhibitory compound obtained at R_f 0.6–0.7, on the thin-layer chromatogram of the neutral fraction, was isolated and identified as coumarin by means of GC-MS. Coumarin solution inhibited seedling growth of <i>Z. japonica</i> in low concentrations but, conversely, promoted seedling growth of <i>A. odoratum</i>. Coumarin was contained in all parts of <i>A. odoratum</i> and its concentration varied with the season and from one individual plant to another. In particular, coumarin was highly concentrated in the leaves, accounting for more than 2.5% of dry leaf weight in June. The inhibitory effect of these aqueous extracts was correlated to the amount of coumarin in <i>A. odoratum</i> leaves and coumarin was considered to be the main inhibitory compound."</p>
	<p>Scott, D. (1975). Allelopathic interactions of resident tussock grassland species on germination of oversown seed. <i>New Zealand Journal of Experimental Agriculture</i>, 3 (2), 135-141</p>	<p>"Like many other grasses, sweet vernal grass contains allelopathic chemicals that suppress the growth of other plant species."</p>

403	Parasitic	n
	Source(s)	Notes
	<p>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.</p>	<p>"Slender perennials, forming small tufts" [Poaceae. No evidence]</p>

404	Unpalatable to grazing animals	n
	Source(s)	Notes

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Qsn #	Question	Answer
	<p>Callaway, R., Kikodze, D., Chiboshvili, M., & Khetsuriani, L. (2005). Unpalatable Plants Protect Neighbors from Grazing and Increase Plant Community Diversity. <i>Ecology</i>, 86(7), 1856-1862</p>	<p>"Abstract. Tasty plants can be protected from herbivores by unpalatable neighbors. We used experimental exclosures, removal of unpalatable species, and transplants of palatable and unpalatable species in subalpine meadows of the Caucasus Mountains of Georgia to study the effects of two unpalatable species on plant communities. We found that <i>Cirsium obalatum</i> and <i>Veratrum lobelianum</i>, two large native perennial herbs that invade after heavy grazing, had strong facilitative effects on communities through their indirect effects on livestock herbivores. These unpalatable invaders had different effects on community composition when livestock were present than when livestock were excluded. Furthermore, removing <i>Cirsium</i> and <i>Veratrum</i> where herbivory was permitted decreased the richness of associated communities, but inside a livestock exclosure removal of these species increased community richness. Transplanted palatable species (<i>Anthoxanthum odoratum</i> and <i>Phleum alpinum</i>) grew larger inside the exclosure, and in the exclosure <i>Cirsium</i> and <i>Veratrum</i> had no effect on their growth. However, outside of the exclosure, <i>Cirsium</i> and <i>Veratrum</i> had strong positive effects on the growth of <i>A. odoratum</i> and <i>P. alpinum</i>. Excluding livestock decreased the growth of <i>Luzula pseudosudetica</i>, another unpalatable species, and <i>Cirsium</i> and <i>Veratrum</i> had no effect on <i>L. pseudosudetica</i> outside the exclosure. In contrast, inside exclosures <i>Cirsium</i> and <i>Veratrum</i> had competitive effects on <i>L. pseudosudetica</i>. Our results indicate that <i>Cirsium</i> and <i>Veratrum</i>, which are in some ways undesirable rangeland weeds, may also play an important role in maintaining species and functional diversity of overgrazed plant communities in the Caucasus." ... "<i>A. odoratum</i> was highly palatable (in the whole-community measurements at Jvari it only occurred naturally inside the exclosure) and of all species it showed the most dramatic increase in the community exclosure treatment (from 0 to -15% cover)."</p>
	<p>Cran, G. & Dillingham, K. 1992. Choosing plant introductions: needs of graziers. Pp. 732-735 in C. P. Stone, C. W. Smith, and J. T. Tunison (eds.). <i>Alien Plant Invasions in Native Ecosystems of Hawai'i: Management and Research</i>. University of Hawaii Cooperative National Park Resources Studies Unit, Honolulu, HI</p>	<p>"As the early grazing industry needed improved varieties, it initially drew upon proven forage plants that were available from temperate areas. In general, these plants did not do well at lower elevations but improved the forage in the cooler regions of Hawai'i. It would be difficult to imagine what Mauna Kea would look like without sweet vernalgrass (<i>Anthoxanthum odoratum</i>), or what Ka'u would be like without meadow ricegrass (<i>Ehrharta stipoides</i>) or kikuyu grass (<i>Pennisetum clandestinum</i>). They have become part of the landscape along with many other introduced plants."</p>
	<p>Quattrocchi, U. 2006. <i>CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology</i>. CRC Press, Boca Raton, FL</p>	<p>"fodder grass, forage, cultivated in hay fields and widely naturalized in temperate regions, not palatable,"</p>

405	Toxic to animals	
	Source(s)	Notes

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Qsn #	Question	Answer
	Runciman, D. J., Lee, A. M., Reed, K. F. M., & Walsh, J. R. (2002). Dicoumarol toxicity in cattle associated with ingestion of silage containing sweet vernal grass (<i>Anthoxanthum odoratum</i>). <i>Australian Veterinary Journal</i> , 80(1-2), 28-32	[Not directly toxic, but indirect poisoning can result] "ABSTRACT: A diagnosis of dicoumarol toxicity in a herd of Friesian cattle was made following investigation of the deaths of three mature cows and eleven yearling heifers. Affected stock had been fed wrapped, bailed silage containing approximately 90% sweet vernal grass (<i>Anthoxanthum odoratum</i>). Sweet vernal grass contains coumarin, which can be converted to dicoumarol, a vitamin K antagonist, through the action of moulds. Most deaths were preceded by lethargy, severe anaemia and subcutaneous and internal haemorrhage. Dicoumarol toxicosis was suspected based on clinical signs, necropsy findings and prolonged prothrombin and activated partial thromboplastin times. Dicoumarol analysis of blood from affected animals and silage confirmed the diagnosis."
	Dwyer, C. J., Downing, G. M., & Gabor, L. J. (2003). Dicoumarol toxicity in neonatal calves associated with the feeding of sweet vernal (<i>Anthoxanthum odoratum</i>) hay. <i>Australian Veterinary Journal</i> , 81(6), 332-335	[Not directly toxic, but indirect poisoning can result] "Neonatal calves from a seasonal dairy herd in North Western Tasmania were presented for veterinary care due to mortalities and bleeding from multiple orifices. Necropsy examination revealed free blood throughout the parenchymatous organs, body cavities and connective tissues. There was no history of anticoagulant exposure, however, high quantities of dicoumarol were found in samples from hay fed to recently calved cows. No Australian cases of dicoumarol toxicity in neonatal calves have been previously documented, and dicoumarol toxicity in adult cattle would appear to be less common than in colder farming regions of the Northern Hemisphere."

406	Host for recognized pests and pathogens	
	Source(s)	Notes
	Weber, E. 2003. <i>Invasive Plant Species of the World. A Reference Guide to Environmental Weeds</i> . CABI Publishing, Wallingford, UK	None specified
	USGS-PIERC. 2005. Pathogens of plants of Hawaii. http://www.hear.org/pph/index.html . [Accessed 16 May 2018]	<i>Puccinia poae-nemoralis</i> - Puccinia
	WRA Specialist. 2018. Personal Communication	Well-studied grass with no mention of being an important alternative host of pests or pathogens

407	Causes allergies or is otherwise toxic to humans	y
	Source(s)	Notes
	Quattrocchi, U. 2006. <i>CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology</i> . CRC Press, Boca Raton, FL	"provocative of hay asthma, it produces a lot of pollen and is a major irritant to people who suffer from hay fever, in Europe inhalation of grass pollen is the predominant cause of hay fever and related hypersensitivity reactions"

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408	Creates a fire hazard in natural ecosystems	y
	Source(s)	Notes
	Dibble, A. C., White, R. H., & Lebow, P. K. (2007). Combustion characteristics of north-eastern USA vegetation tested in the cone calorimeter: invasive versus non-invasive plants. <i>International Journal of Wildland Fire</i> 16: 426–443	"In some forest stands, invasive grasses such as wood blue-grass (<i>Poa nemoralis</i> L.), Japanese stiltgrass (included in the present study), fine-leaved sheep fescue (<i>Festuca filiformis</i> Pourret), and sweet vernal grass (<i>Anthoxanthum odoratum</i> L.) changed the fuel bed by significantly increasing the load of continuous fine fuels."

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	Notes
	Plants for a Future. 2018. <i>Anthoxanthum odoratum</i> . https://www.pfaf.org/user . [Accessed 16 May 2018]	"It cannot grow in the shade."
	Dave's Garden. 2018. Sweet Vernal Grass, Vanilla Grass - <i>Anthoxanthum odoratum</i> . https://davesgarden.com/guides/pf/go/32276/ . [Accessed 23 May 2018]	"Sun Exposure: Full Sun"

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	Notes
	Quattrocchi, U. 2006. <i>CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology</i> . CRC Press, Boca Raton, FL	"in a great variety of habitats and on a wide range of soils"
	Krautzer, B., Peratoner, G. & Bozzo, F. 2004. Site-Specific Grasses and Herbs. Seed production and use for restoration of mountain environments. FAO, Rome. http://www.fao.org . [Accessed 16 May 2018]	"This species grows on soil that is free of groundwater, and on almost any meadow land. As a result of its low growth, it prefers meadows. Apart from rocks and rough debris the plant grows on almost any moist to semiarid soil with a low to intermediate nutrient supply and a pH between 3.2 and 6.5."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Wagner, W.L., Herbst, D.R. & Sohmer, S.H. 1999. <i>Manual of the flowering plants of Hawaii</i> . Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Slender perennials, forming small tufts"

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Qsn #	Question	Answer
412	Forms dense thickets	y
	Source(s)	Notes
	Loope, L.L., Nagata, R.J. & Medeiros, A.C. 1992, Alien plants in Haleakala National Park Pp. 551-576 in Stone et al (eds) Alien plant invasions in native ecosystems of Hawaii. Coop. Nat. Park Resources Studies Unit, University of Hawaii, Honolulu, HI	"The often dense mat of alien grasses such as velvet grass (<i>Holcus lanatus</i>), sweet vernalgrass (<i>Anthoxanthum odoratum</i>), and orchard grass (<i>Dactylis glomerata</i>) inhibits reproduction by seed of native shrubs."
	Smith, C.W. 1985. Impact of Alien Plants on Hawaii's Native Biota. Pp. 180-250 in Stone & Scott (eds.). Hawaii's terrestrial ecosystems: preservation & management. CPSU, Honolulu, HI	"This small, perennial bunchgrass forms extensive ground cover in open mesic and dry habitats at high elevations, It invades disturbed areas, preventing the reestablishment of native species,"

501	Aquatic	n
	Source(s)	Notes
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[Terrestrial] "found in mixed pastures and meadows, open fields, along roadsides, waste places, woods, in damp sites, herbaceous swamp, hill pasture and heath, fields, moors, boggy sites, clay soils,"

502	Grass	y
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 16 May 2018]	Family: Poaceae (alt.Gramineae) Subfamily: Pooideae Tribe: Poeae Subtribe: Anthoxanthinae

503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 16 May 2018]	Family: Poaceae (alt.Gramineae) Subfamily: Pooideae Tribe: Poeae Subtribe: Anthoxanthinae

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	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.	"Slender perennials, forming small tufts; culms erect or spreading, 30-60 cm long, ca. 1 mm in diameter, hollow, glabrous, nodes darker than internodes, glabrous."

L.

Qsn #	Question	Answer
601	Evidence of substantial reproductive failure in native habitat	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] "Native to Eurasia and now widely naturalized in temperate North America"

602	Produces viable seed	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.	"Caryopsis linear, 1.3-2.5 mm long."
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"reproduces by seeds dispersed by wind"
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"The grass reproduces by seeds and does not spread vegetatively."

603	Hybridizes naturally	
	Source(s)	Notes
	Jones, K. (1964). Chromosomes and the nature and origin of <i>Anthoxanthum odoratum</i> L. <i>Chromosoma</i> , 15(3), 248-274	[Unknown, but may be of hybrid origin] "It is concluded that <i>odoratum</i> is not autotetraploid but a species of hybrid origin. This denies the diploid-autotetraploid relationship of <i>alpinum</i> and <i>odoratum</i> suggested by earlier workers and substantiates their separate classification."

604	Self-compatible or apomictic	n
	Source(s)	Notes
	Roach, D. (1987). Variation in Seed and Seedling Size in <i>Anthoxanthum odoratum</i> . <i>The American Midland Naturalist</i> , 117(2), 258-264	" <i>A. odoratum</i> is self-incompatible and wind-pollinated"
	Wu, L., & Jain, S. (1980). Self-fertility and seed set in natural populations of <i>Anthoxanthum odoratum</i> L. <i>Botanical Gazette</i> , 141(3), 300-304	"The breeding system in <i>Anthoxanthum odoratum</i> populations from a perennial grassland was investigated for the occurrence of self-fertility. Several experimental tests consistently showed a very low frequency of self-fertility, less than 0.2%. No plant had a high rate of selfing. Plants raised from selfed seed showed inbreeding depression in terms of high seedling mortality. Variation in seed set among populations in their natural habitat appeared to result from differences in their population structure. Further research on the role of self-fertility in the colonizing ability of <i>A. odoratum</i> is discussed."

605	Requires specialist pollinators	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Zomlefer, W.B. 1994. Guide to Flowering Plant Families. The University of North Carolina Press, Chapel Hill & London	"The reduced flowers are anemophilous" [Poaceae]

606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"The grass reproduces by seeds and does not spread vegetatively."

607	Minimum generative time (years)	1
	Source(s)	Notes
	Krautzer, B., Peratoner, G. & Bozzo, F. 2004. Site-Specific Grasses and Herbs. Seed production and use for restoration of mountain environments. FAO, Rome. http://www.fao.org . [Accessed]	"Annual grass growing in bunches, or perennial with short, thin rhizomes and numerous young shoots."
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"The species is highly competitive to other grass species because it grows rapidly and flowers earlier than native species"

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	Notes
	Strykstra, R. J., Verweij, G. L., & Bakker, J. P. (1997). Seed dispersal by mowing machinery in a Dutch brook valley system. <i>Acta Botanica Neerlandica</i> , 46(4), 387-401	"Seed dispersal by mowing machinery was investigated within a grassland reserve. Transported seed numbers amounted to hundreds of thousands. Seeds of 26 species were found on the machinery, including species that play an important role in succession during vegetation restoration (<i>Holcus lanatus</i> , <i>Rhinanthus angustifolius</i> , <i>Anthoxanthum odoratum</i>)."
	Johnston, F.M. 2005. Exotic Plants in the Australian Alps Including a Case Study of the Ecology of <i>Achillea millefolium</i> , in Kosciuszko National Park. PhD Dissertation. Griffith University. Gold Coast, AU	"Species found along the road verge in this study, such as <i>Acetosella vulgaris</i> , <i>Anthoxanthum odoratum</i> ...are commonly associated with human disturbance in the Australian Alps...The road verge seed banks were dominated by exotic propagules, particularly <i>Acetosella vulgaris</i> , <i>Achillea millefolium</i> , <i>Anthoxanthum odoratum</i> ..." [species spread along roadsides]

L.

Qsn #	Question	Answer
702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"A. odoratum has already been spread to many countries where it can grow successfully. It could still be accidentally or deliberately spread further within those countries and to other countries where it has not yet established, but modern phytosanitary precautions at borders should limit the chances of further spread to more countries."
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"cultivated in hay fields and widely naturalized in temperate regions"

703	Propagules likely to disperse as a produce contaminant	y
	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, Herbal, Ornamental, Pasture"
	USDA, ARS, Germplasm Resources Information Network. 2018. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 16 May 2018]	"Weed: potential seed contaminant"
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	[Could become spread inadvertently in hay or silage] "Coastal dunes, grass- and heathland, forests, freshwater wetlands, riparian habitats...The species is highly competitive to other grass species because it grows rapidly and flowers earlier than native species"

704	Propagules adapted to wind dispersal	y
	Source(s)	Notes
	Smith, C.W. 1985. Impact of Alien Plants on Hawaii's Native Biota. Pp. 180-250 in Stone & Scott (eds.). Hawaii's terrestrial ecosystems: preservation & management. CPSU, Honolulu, HI	"The seeds are dispersed by wind."

705	Propagules water dispersed	
	Source(s)	Notes
	Quattrocchi, U. 2006. CRC World Dictionary of Grasses: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[Possibly yes in boggy areas] "found in mixed pastures and meadows, open fields, along roadsides, waste places, woods, in damp sites, herbaceous swamp, hill pasture and heath, fields, moors, boggy sites"
	Pacific Island Ecosystems at Risk (PIER). 2017. <i>Anthoxanthum odoratum</i> . http://www.hear.org/Pier . [Accessed 16 May 2018]	[Possibly yes, but generally not found in riparian areas in Hawaiian Islands] "Seed, dispersed by wind, water and animals."

706	Propagules bird dispersed	n
	Source(s)	Notes

L.

Qsn #	Question	Answer
	Smith, C.W. 1985. Impact of Alien Plants on Hawaii's Native Biota. Pp. 180-250 in Stone & Scott (eds.). Hawaii's terrestrial ecosystems: preservation & management. CPSU, Honolulu, HI	"The seeds are dispersed by wind."

707	Propagules dispersed by other animals (externally)	
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Lambrechtsen (1968) said that the long barbed awn and hairy spikelet easily hook onto animals and probably even birds so that animals may contribute markedly to the distribution of <i>A. odoratum</i> seed"
	Pacific Island Ecosystems at Risk (PIER). 2017. <i>Anthoxanthum odoratum</i> . http://www.hear.org/Pier. [Accessed 16 May 2018]	"Seed, dispersed by wind, water and animals." [awns could possibly stick to fur]

708	Propagules survive passage through the gut	y
	Source(s)	Notes
	Cosyns, E. 2004. Ungulate Seed dispersal. Aspect of endozoochory in a semi-natural landscape. PhD Dissertation. Ghent University, Gent, Belgium	"Final Germination success of <i>Veronica chamaedrys</i> , <i>Prunella vulgaris</i> , <i>Crepis capillaris</i> and <i>Anthoxanthum odoratum</i> seeds which passed through rabbit guts was significantly higher than of those fed to sheep, cattle [but not <i>A. odoratum</i>], to donkey [only for <i>C. capillaris</i>] and horse [only <i>A. odoratum</i>]."
	Welch, D. (1985). Studies in the grazing of heather moorland in north-east Scotland. IV. Seed dispersal and plant establishment in dung. <i>Journal of Applied Ecology</i> , 22(2): 461-472	"Surveys at the moorland sites showed that <i>Anthoxanthum odoratum</i> , <i>Holcus lanatus</i> , <i>Poa annua</i> and <i>Poa pratensis</i> were the grasses most frequently introduced; increase in the number of their establishments was associated with heavy dung deposition by cattle."
	Bruun, H. H., & Poschlod, P. (2006). Why are small seeds dispersed through animal guts: large numbers or seed size per se?. <i>Oikos</i> , 113(3): 402-411	viable <i>A. odoratum</i> seeds in dung...listed as Animal dispersed

801	Prolific seed production (>1000/m2)	y
	Source(s)	Notes
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"A single plant may produce >1000 seeds per year."
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Lambrechtsen (1968) recorded about 30,000 seeds per plant, but mentioned that other authors had reported smaller numbers. The same author went on to say that although seeds germinate readily in the light, if buried they can remain viable in the soil for five years or more. Milton (1936), reported in Lambrechtsen (1968), found up to 6.2 million <i>A. odoratum</i> seeds per hectare in fields with swards up to five years old, and up to 11.25 million seeds per hectare in fields with swards more than five years old."

802	Evidence that a persistent propagule bank is formed (>1 yr)	y

L.

Qsn #	Question	Answer
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Plants can live for 3 to 5 years (Lambrechtsen, 1968); Antonovics (1972) suggested that in practice the half-life of a population is about 2 years. However, seeds buried in the soil can last for 5 years or more and large populations can accumulate in seed banks in the soil (Milton, 1936)."
	Bekker, R. M., Knevel, I. C., Tallowin, J. B. R., Troost, E. M. L., & Bakker, J. P. (1998). Soil nutrient input effects on seed longevity: a burial experiment with fen-meadow species. <i>Functional Ecology</i> , 12(4), 673-682	"The species <i>A. odoratum</i> and <i>C. paludosa</i> show a very drastic decline in viable seed numbers after 2 years which might support transient behaviour as was found in the database of Thompson et al. 1997."

803	Well controlled by herbicides	y
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Many herbicides (for example glyphosate) give excellent control of <i>A. odoratum</i> but will also kill other grasses or other species that they contact. Pitcher and Russo (1988) suggest that dalapon could be useful: it kills other grasses, but not broadleaf plants. Dalapon is also recommended in the Florabase database (Western Australian Herbarium, 2013). More modern herbicides like fluazifop-butyl or haloxyfop also kill most grasses without damaging broad-leafed plants. Spot treatment or broadcast spraying with herbicides is possible, but bare areas must be resown with desirable species as soon as possible afterwards."
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"The herbicide dalapon has proved to be effective for control of this grass."

804	Tolerates, or benefits from, mutilation, cultivation, or fire	
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Cattle and sheep readily graze <i>A. odoratum</i> in most seasons, but it may become less palatable in summer, possibly because of higher levels of coumarin (Lambrechtsen, 1968)."
	Smith, C.W. 1985. Impact of Alien Plants on Hawaii's Native Biota. Pp. 180-250 in Stone & Scott (eds.). Hawaii's terrestrial ecosystems: preservation & management. CPSU, Honolulu, HI	"Its cover increases after fire, but this increase appears to be the result of reduced competition rather than stimulation."
	Weber, E. 2003. Invasive Plant Species of the World. A Reference Guide to Environmental Weeds. CABI Publishing, Wallingford, UK	"Manual control includes hand pulling of individual plants and mowing."

L.

Qsn #	Question	Answer
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Grasses have rarely been successfully targeted in biocontrol activities because too many useful grasses might also be affected."
	Smith, C.W. 1985. Impact of Alien Plants on Hawaii's Native Biota. Pp. 180-250 in Stone & Scott (eds.). Hawaii's terrestrial ecosystems: preservation & management. CPSU, Honolulu, HI	"It has not been evaluated for biological control,"

L.

Summary of Risk Traits:

High Risk / Undesirable Traits

- Broad climate suitability & elevation range exceeds 1000 m, demonstrating environmental versatility
- Grows in upper elevations of subtropical islands
- Naturalized on Kauai, Oahu, Molokai, Maui, & Hawaii (Hawaiian Islands) & widely naturalized elsewhere
- A disturbance adapted weed with negative environmental impact
- Other *Anthoxanthum* species are invasive
- Allelopathic
- Can be indirectly toxic to grazing animals
- Pollen causes asthma & allergies
- Can create a fire hazard in invaded ecosystems
- Tolerates many soil types
- Forms dense mats that can prevent native seedling regeneration
- Reproduces by seeds
- Can reach maturity in one growing season
- Seeds dispersed by adhering to machinery, as a contaminant, by wind, & internally by grazing animals
- Prolific seed production
- Seeds may remain viable for 2-5 years

Low Risk Traits

- From temperate regions (may limit ability to invade to higher elevations of tropical islands)
- Unarmed (no spines, thorns, or burrs)
- Provides forage for grazing animals
- Grows in full sun (shade may limit spread)
- Self-incompatible
- Not reported to spread vegetatively
- Herbicides may provide effective control