

Taxon: <i>Parthenium argentatum</i> A. Gray	Family: Asteraceae
Common Name(s): guayule Mexican-rubber	Synonym(s): <i>P. argentatum</i> f. <i>argentatum</i> <i>P. argentatum</i> var. <i>argentatum</i>

Assessor: Chuck Chimera	Status: Assessor Approved	End Date: 21 Apr 2016
WRA Score: 5.0	Designation: EVALUATE	Rating: Evaluate

Keywords: Subtropical Shrub, Rubber Source, Apomictic, Prolific Seeder, 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)	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	n
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	n
302	Garden/amenity/disturbance weed	n=0, y = 1*multiplier (see Appendix 2)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	n
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals		
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	n
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
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		
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally	y=1, n=-1	y
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation		
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	n
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant		
704	Propagules adapted to wind dispersal	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)	y=1, n=-1	n
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m ²)	y=1, n=-1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides		
804	Tolerates, or benefits from, mutilation, cultivation, or fire	y=1, n=-1	y
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
	Ray, D. T., Coffelt, T. A., & Dierig, D. A. (2005). Breeding guayule for commercial production. <i>Industrial Crops and Products</i> , 22(1), 15-25	[Breeding & domestication in process] "Breeding a new domestic crop, such as guayule, is not appreciably different from enhancement and breeding of conventional crops. In both instances, plant breeders take the available germplasm and search for genetic variability in the desired traits. The major differences are that in new crops plant breeders are often working with an unfamiliar species that is not yet fully domesticated and the available germplasm is often limited. The main objective of the guayule breeding program is to facilitate successful commercialization by developing higher yielding cultivars."
	Dempewolf, H., Rieseberg, L. H., & Cronk, Q. C. (2008). Crop domestication in the Compositae: a family-wide trait assessment. <i>Genetic Resources and Crop Evolution</i> , 55(8), 1141-1157	[<i>Parthenium argentatum</i> - Domestication category = Weak/no] "Signs of domestication are weak or absent in Compositae species of medicinal or industrial value. None of the latter have been heavily cultivated for a long time, benefited from modern breeding efforts or been grown in environments that are intensively controlled by humans" ... "Table 2 Degree of domestication for some species in the Compositae that are suitable for human consumption"

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. 2016. 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
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 18 Apr 2016]	"Native: Northern America Northern Mexico: Mexico - Chihuahua, - Coahuila, - Durango, - Nuevo Leon, - San Luis Potosi, - Zacatecas South-Central U.S.A.: United States - Texas Southern Mexico: Mexico - Hidalgo"

Qsn #	Question	Answer
202	Quality of climate match data	High
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 18 Apr 2016]	

203	Broad climate suitability (environmental versatility)	n
	Source(s)	Notes
	Flora of North America Editorial Committee. 2006. Flora of North America North of Mexico. Vol. 21. New York and Oxford	"Calcareous soils; 1000–1500 m; Tex.; Mexico."
	Tideman,, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"Guayule grows wild in some semi-arid regions of North America such as the Stockton Plateau and Big Bend region of Texas. It is native to the upland plateaus in Mexico and Texas with subtropical-temperate climates, where rainfall is low and erratic."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 18 Apr 2016]	"Native: Northern America Northern Mexico: Mexico - Chihuahua, - Coahuila, - Durango, - Nuevo Leon, - San Luis Potosi, - Zacatecas South-Central U.S.A.: United States - Texas Southern Mexico: Mexico - Hidalgo"

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	Cultivated in a number of locations outside native range as a potential source of latex for rubber production

Qsn #	Question	Answer
301	Naturalized beyond native range	n
	Source(s)	Notes
	Maroyi, A. (2006). Preliminary checklist of introduced and naturalized plants in Zimbabwe. <i>Kirkia</i> , 18(2): 177-247	[Introduced, but not documented as naturalized] " <i>Parthenium argentatum</i> ... cultivated in experimental plots"
	Howard, R. A., & Powell, D. A. (1963). The introduction of rubber producing species in the West Indies. <i>Economic Botany</i> , 17(4), 337-349	[No evidence] "During the revival of interest in rubber- producing plants during World War II, guayule was introduced to Jamaica as seed. The germination was reported as poor, and the plants which grew proved extremely difficult to transplant. In 1945, the work of <i>Parthenium argentatum</i> was discontinued"
	Randall, R.P. 2012. <i>A Global Compendium of Weeds</i> . 2nd Edition. Department of Agriculture and Food, Western Australia	No evidence

302	Garden/amenity/disturbance weed	n
	Source(s)	Notes
	Randall, R.P. 2012. <i>A Global Compendium of Weeds</i> . 2nd Edition. Department of Agriculture and Food, Western Australia	No evidence

303	Agricultural/forestry/horticultural weed	n
	Source(s)	Notes
	Randall, R.P. 2012. <i>A Global Compendium of Weeds</i> . 2nd Edition. Department of Agriculture and Food, Western Australia	No evidence

304	Environmental weed	n
	Source(s)	Notes
	Randall, R.P. 2012. <i>A Global Compendium of Weeds</i> . 2nd Edition. Department of Agriculture and Food, Western Australia	No evidence

305	Congeneric weed	y
	Source(s)	Notes
	Tideman,, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"Guayule is closely related to parthenium weed (<i>Parthenium hysterophorus</i>) which has been proclaimed a primary pest plant on Schedule I of the Pest Plants Act (S.A.) 1975. This is a serious weedy species first found in Australia in Queensland in 1955 and is now widespread. It is a serious weed in Asia and North America. There is however no evidence that guayule will become weedy."
	Parsons, W.T. & Cuthbertson, E.G. 2001. <i>Noxious Weeds of Australia</i> . Second Edition. CSIRO Publishing, Collingwood, Australia	[<i>Parthenium hysterophorus</i> - noxious weed in Australia] " <i>Parthenium</i> weed is an aggressive colonizer of fallows, wastelands, roadsides and overgrazed pastures." ... "While not yet a major weed of crops, it has the potential to become a serious problem of all medium rangelands in Australia as well as all summer cropping areas."

Qsn #	Question	Answer
401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Flora of North America Editorial Committee. 2006. Flora of North America North of Mexico. Vol. 21. New York and Oxford	[No evidence] "Shrubs, 30–100+ cm. Leaf blades lanceolate to oblanceolate, 15–25(–40+) × 6–15(–25+) mm, margins mostly entire, some with 1–2(–5) sharp teeth, faces densely strigillose (gray to white) and obscurely or not at all gland-dotted."

402	Allelopathic	
	Source(s)	Notes
	Schloman, W. W., Hilton, A. S., & McGrady, J. J. (1991). Allelopathic response of vegetables to guayule residue. <i>Bioresource Technology</i> , 35(2), 191-196	[Demonstrates allelopathic properties in laboratory conditions] "Water leachates from guayule processing residues or residues mixed with peat moss or soil significantly delay germination onset and decrease percentage germination for the following crops: broccoli, cantaloupe, cauliflower, cotton, guayule, lettuce, pepper, and tomato. These effects can be ascribed to p-anisic acid present in leaf resin and a variety of substituted benzoic and cinnamic acids present as carboxylate salts in leaves and bagasse."
	Gao, X. X., Li, M., Xie, H., Gao, Z. J., Zhang, X. R., Zhang, Y. L., Cao A. C. & Kong, J. H. (2012). Allelopathic effects of <i>Parthenium argentatum</i> on seed germination and seedling growth of three plant species. <i>Pratacultural Science</i> , 6, 009	Allelopathic effects of aqueous extracts and powder of different parts of <i>Parthenium hysterophorus</i> on seed germination and seedling growth of <i>Abutilon theophrasti</i> , <i>Digitaria sanguinalis</i> , and <i>Raphanus sativus</i> were evaluated either in petri dishes or a greenhouse. The results showed that the aqueous extracts of roots, stems, leaves and fruits all had negative effects on the seed germination and seedling growth of three tested plants, while the aqueous extracts from leaves and fruits had higher inhibiting on the seed germination and seedling growth of all tested plants than those from roots and stems. <i>A. theophrasti</i> and <i>R. sativus</i> were more sensitive to the extracts than <i>D. sanguinalis</i> . This conclusion was also confirmed by testing seed germination and seedling growth of the three plants in the mixture of 25 g powder (from different parts of <i>P. argentatum</i>) with 1 kg soil in a greenhouse."

403	Parasitic	n
	Source(s)	Notes
	Flora of North America Editorial Committee. 2006. Flora of North America North of Mexico. Vol. 21. New York and Oxford	"Shrubs, 30–100+ cm." [Asteraceae. No evidence]

404	Unpalatable to grazing animals	n
	Source(s)	Notes

Qsn #	Question	Answer
	Lloyd, F. E. (1911). Guayule (<i>Parthenium argentatum</i> Gray): A Rubber-plant of the Chihuahuan Desert (No. 139). Carnegie Institution of Washington, Washington, D.C.	"It has been pointed out that the growing guayule is browsed by animals. Burros, jack-rabbits, cotton-tails, and goats are all given to this, and as these animals are numerous a great loss is entailed. Goats are herded habitually in the guayule fields, and these animals, with their all-devouring appetites, eat almost everything that grows. Not the least damage done by them is the wholesale destruction of the developing shoots and flower-buds, reducing the crop of seeds very greatly. Goats and burros may, however, be pastured away from the guayule fields, and thus loss may be avoided. The work of rabbits* where other food is available, is not serious, though in the event of adopting forestry methods they may become a menace to the plant. These marauders do not merely crop off the foliage and new shoots; they lop off whole branches, which are left on the ground to die. One jack-rabbit may therefore do a great deal more damage than a goat in the same time."
	Jameson, D. A., Armijo-T, J. R., Medina-T, J. G., & Nava-C, R. (1984). Marginal benefits of grazing and agricultural practices on a Mexican ejido. <i>Journal of Range Management</i> , 37(3): 195-200.	"On the Agave- <i>Parthenium</i> type, <i>Parthenium argentum</i> is very susceptible to competition from other plants. In a preliminary study Gonzales (1982) found that goats do not readily browse <i>Parthenium argentum</i> but do browse other species of <i>Parthenium</i> . Thus, a program of agave gathering and goat grazing could be designed to promote growth of guayule." [In contrast to Lloyd 1911]

405	Toxic to animals	
	Source(s)	Notes
	Nelson, L., Shih, R.D. & Balick, M.J. 2007. Handbook of poisonous and injurious plants, The New York Botanical Garden. Springer, New York, NY	"TABLE 4. Representative Plants Causing Contact Dermatitis" [Includes <i>Parthenium argentatum</i>]
	Lloyd, F. E. (1911). Guayule (<i>Parthenium argentatum</i> Gray): A Rubber-plant of the Chihuahuan Desert (No. 139). Carnegie Institution of Washington, Washington, D.C.	[No evidence, although sap causes dermatitis in humans & may have detrimental effects on some animals] "It has been pointed out that the growing guayule is browsed by animals. Burros, jack-rabbits, cotton-tails, and goats are all given to this, and as these animals are numerous a great loss is entailed."

406	Host for recognized pests and pathogens	
	Source(s)	Notes
	Fangmeier, D. D., Rubis, D. D., Taylor, B. B., & Foster, K. E. (1984). Guayule for rubber production in Arizona. Technical Bulletin #252. Agricultural Experiment Station, College of Agriculture, University of Arizona, Tucson, AZ	"Approximately 20 pathogens of guayule are known; the most important of these are associated with soils. Recent isolations from "distressed" greenhouse or field plants in Arizona include <i>Fusarium</i> spp, <i>Rhizoctonia Solani</i> , <i>Phytophthora</i> spp, <i>Pythium</i> spp, <i>Macrophomina phaseolina</i> and <i>Verticillium dahliae</i> . <i>Fusarium</i> and <i>Rhizoctonia</i> have been encountered most frequently."
	Hammond, B. L., & Polhamus, L. G. (1965). Research on guayule (<i>Parthenium argentatum</i>), 1942-1959 (No. 1327). US Department of Agriculture, Washington, D.C.	"Extensive investigations of insect pests found in the greenhouse, nurseries, and in fields were conducted by the Emergency Rubber Project. Cassidy et al. (53) summarized the literature pertaining to insects and mites infesting guayule with notes on control. In general, the potentialities of damage from insects were apparently not serious. Of the several dozen species studied, the two types of most economic importance in guayule fields and nurseries were grasshoppers and Lygus bugs."

Qsn #	Question	Answer
	Tideman,, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"Phytophthora root rot disease. This team at is studying these fungi and has isolated various strains, <i>Parthenium icanum</i> and <i>P. confertium</i> two species closely related to guayule are highly resistant to both diseases."
	Starr, M. P. (1947). The causal agent of bacterial root and stem disease of Guayule. <i>Phytopathology</i> , 37(5), 291-300	"The name proposed for the bacterium responsible for a stem and root disease of guayule (<i>Parthenium argentatum</i>) in California [see preceding abstract] is <i>Erwinia carotovora</i> f. sp. <i>parthenii</i> n.f.sp. The morphology, staining, reactions, and cultural characters of the guayule pathogen on various media are fully described. It differs from <i>E. carotovora</i> only in some cultural properties, e.g., in the production of indole, the peptonization of milk, the failure to grow on sterilized potato, and its ability to attack guayule. Inoculation experiments on guayule with <i>E. carotovora</i> from other hosts, as well as with <i>E. oleraceae</i> from cauliflower, <i>E. rhapontiei</i> from rhubarb, and <i>E. solanisapra</i> and <i>E. atroseptica</i> [<i>E. phytophthora</i>] from potato gave negative results, whereas the plants infected with <i>E. carotovora</i> f. sp. <i>parthenii</i> rapidly succumbed to the typical stem and root rot."

407	Causes allergies or is otherwise toxic to humans	y
	Source(s)	Notes
	Duke, J.A. (2008). <i>Duke's Handbook of Medicinal Plants of Latin America</i> . CRC Press, Boca Raton, FL	"Guayulin A, a sesquiterpene cinnamic acid ester present in the resin, is a potent elicitor of allergenic contact dermatitis, comparable to poison ivy."
	Nelson, L., Shih, R.D. & Balick, M.J. 2007. <i>Handbook of poisonous and injurious plants</i> , The New York Botanical Garden. Springer, New York, NY	"TABLE 4. Representative Plants Causing Contact Dermatitis" [Includes <i>Parthenium argentatum</i>]

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	National Academy of Sciences. (1977). <i>Guayule: An Alternative Source of Natural Rubber</i> . NAS, Washington, D.C.	[No evidence of increased fire frequency in native habitat] "Native to a semiarid area in north-central Mexico and southern Texas, guayule occurs in stands scattered throughout 130,000 sq mi (337,000 sq km) of the Chihuahuan Desert and surrounding regions. In the United States, the shrub is found wild in the Trans Pecos area (Stockton Plateau and Big Bend region) of southwestern Texas."

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	Notes
	Miller, G. O. (2006). <i>Landscaping with Native Plants of Texas</i> . Voyageur Press, St. Paul, MN	"Exposure: full sun"
	Tideman,, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"Guayule is slow growing and is quickly overgrown and shaded by weeds. If shaded guayule dies and only a very low density of weeds can severely stunt the plants."

Qsn #	Question	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	
	Source(s)	Notes
	Fangmeier, D. D., Rubis, D. D., Taylor, B. B., & Foster, K. E. (1984). Guayule for rubber production in Arizona. Technical Bulletin #252. Agricultural Experiment Station, College of Agriculture, University of Arizona, Tucson, AZ	"In its natural habitat guayule is found on shallow, calcareous, stony soils that are well drained."
	Tideman,, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"It is native to the upland plateaus in Mexico and Texas with subtropical- temperate climates, where rainfall is low and erratic. Here it grows in a wide variety of shallow, stony, calcareous, and friable soils."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Flora of North America Editorial Committee. 2006. Flora of North America North of Mexico. Vol. 21. New York and Oxford	"Shrubs, 30–100+ cm."

412	Forms dense thickets	
	Source(s)	Notes
	Tideman,, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"Guayule is slow growing and is quickly overgrown and shaded by weeds. If shaded guayule dies and only a very low density of weeds can severely stunt the plants."
	National Academy of Sciences. (1977). Guayule: An Alternative Source of Natural Rubber. NAS, Washington, D.C.	"The Government of Mexico has recently surveyed its wild guayule and charted over 10 million acres (4 million ha) of accessible, dense stands of native bushes suitable for commercial harvest."
	Muller, C. H. (1947). Vegetation and climate of Coahuila, Mexico. <i>Madroño</i> , 9(2), 33-57	"[Forms dense stands on limestone, but is a poor competitor elsewhere] "Over much of the area of the Grassland Transition on limestone hills there occur more or less dense stands of <i>Parthenium argentatum</i> A. Gray (guayule), a species that competes poorly with both the grasses and the desert shrubs. Of the several characteristic transition species, it is the most obligate member of this vegetation type."

501	Aquatic	n
	Source(s)	Notes
	Tideman,, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"[Terrestrial] "Guayule grows wild in some semi-arid regions of North America such as the Stockton Plateau and Big Bend region of Texas. It is native to the upland plateaus in Mexico and Texas with subtropical- temperate climates, where rainfall is low and erratic. Here it grows in a wide variety of shallow, stony, calcareous, and friable soils."

Qsn #	Question	Answer
502	Grass	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 18 Apr 2016]	"Family: Asteraceae (alt.Compositae)"
503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 18 Apr 2016]	Asteraceae
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Flora of North America Editorial Committee. 2006. Flora of North America North of Mexico. Vol. 21. New York and Oxford	"Shrubs, 30–100+ cm."
601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Flora of North America Editorial Committee. 2006. Flora of North America North of Mexico. Vol. 21. New York and Oxford	No evidence
602	Produces viable seed	y
	Source(s)	Notes
	Naqvi, H. H., & Hanson, G. P. (1982). Germination and growth inhibitors in guayule (<i>Parthenium argentatum</i> Gray) chaff and their possible influence in seed dormancy. <i>American Journal of Botany</i> , 69(6): 985-989.	"Guayule is mainly propagated through seed. The dispersal unit consists of an achene which is enclosed by two staminate florets and a subtending bract."

Qsn #	Question	Answer
603	Hybridizes naturally	y
	Source(s)	Notes
	Rollins, R. C. (1944). Evidence for natural hybridity between guayule (<i>Parthenium argentatum</i>) and mariola (<i>Parthenium incanum</i>). <i>American Journal of Botany</i> , 31(2): 93-99	"One hundred sixty-two hybrids from immediate crosses in nature between Guayule (<i>Parthenium argentatum</i> Gray) and Mariola (<i>Parthenium incanum</i> H. B. K.) have been identified from a greenhouse population of about 205,000 Guayule plants grown from seeds collected in the wild. Thus, less than one-tenth of one per cent of the total are hybrids. Hybrid plants were found in cultures of the usual type Guayule, the microtrichome type and the "intermediate type." A single hybrid was discovered among nearly a thousand plants of Mariola."

Qsn #	Question	Answer
604	Self-compatible or apomictic	y
	Source(s)	Notes
	Gerstel, D. U., & Wm. Mishanec. (1950). On the Inheritance of Apomixis in <i>Parthenium argentatum</i> . <i>Botanical Gazette</i> , 112(1), 96-106	"Guayule (<i>Parthenium argentatum</i> Gray) is part of an apomictic complex (I6) in which the diploid (2n = 36) races reproduce sexually, but the polyploids with 54 or more chromosomes are facultative apomicts (3, I 6, 22) .2 This distinction is quite general in the wild; under cultivation apomictic "haploid" plants with approximately the diploid number of chromosomes can survive."

Qsn #	Question	Answer
605	Requires specialist pollinators	n
	Source(s)	Notes
	Mamood, A. N., Ray, D. T., & Waller, G. D. (1990). Seed set in Guayule (<i>Parthenium argentatum</i> , Asteraceae) in relation to insect pollination. <i>Economic Botany</i> , 44(4), 440-444	"Guayule (<i>Parthenium argentatum</i> , Asteraceae) is one of two major plant species grown for natural rubber. Studies were conducted to determine the effect of honey bee (<i>Apis mellifera</i>) pollination and season on seed set and total seed yield/ha. The experiments involved four pollination treatments: plants caged with bees; plants caged without bees; plants open pollinated (uncovered); and plants individually covered. Seeds were harvested monthly July September 1984, and May-September 1985. Plots with bees produced at least 150% more seeds than plots without bees, and there were no qualitative differences in the seed weights among treatments. Highest seed yield was in May and September. Results indicate that (1) insect pollination in guayule increases seed yield and (2) fewer seeds are produced in the warmest months."
	Tideman, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"Guayule flowers are pollinated by wind and by insects."

Qsn #	Question	Answer
606	Reproduction by vegetative fragmentation	
	Source(s)	Notes
	Naqvi, H. H., & Hanson, G. P. (1982). Germination and growth inhibitors in guayule (<i>Parthenium argentatum</i> Gray) chaff and their possible influence in seed dormancy. <i>American Journal of Botany</i> , 69(6): 985-989.	"Guayule is mainly propagated through seed. The dispersal unit consists of an achene which is enclosed by two staminate florets and a subtending bract."

Qsn #	Question	Answer
	Lloyd, F. E. (1911). Guayule (<i>Parthenium argentatum</i> Gray): A Rubber-plant of the Chihuahuan Desert (No. 139). Carnegie Institution of Washington, Washington, D.C.	[Possible, but very uncommon] "Both the Mexican guayule (<i>Parthenium argentatum</i> A. Gray) and its congener, the mariola (<i>P. incanum</i> BL B. K.), exhibit methods of vegetative reproduction which, while shared by other plants, are not common to these under the normal conditions of growth." ... "The root-system of the guayule, on the other hand, consists of a strong tap-root and several strong laterals, which arise at a short distance below the surface of the soil (plate 9, fig. A). These follow a horizontal path for a distance, it may be, of 2 meters or more from the plant, and constitute a water collecting system by which the plant derives water from rain-water which does not penetrate deeply—a feature shared by many desert plants (Cannon, 1911). These shallow roots frequently produce root-shoots (retonos) at various distances from the parent stock. I have found them at a meter distant, and it is likely that they may arise still farther away, though I believe less often than at shorter distances. It may be presumed that shoots, arising, as they not infrequently do, from the basal portion of the main axis, may occasionally strike root as in the mariola. Many thousands of plants, however, have been examined, and only one or two cases have been found which may be permitted this interpretation. We may therefore regard the method described as the only normal method of vegetative reproduction under natural conditions, though it has been observed to occur in the field (Station 5) in two cases in which the aerial portion of the plant had been removed."

607	Minimum generative time (years)	1
	Source(s)	Notes
	National Academy of Sciences. (1977). Guayule: An Alternative Source of Natural Rubber. NAS, Washington, D.C.	"Flowers and seeds are produced as early as six months after germination."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	n
	Source(s)	Notes
	Lloyd, F. E. (1911). Guayule (<i>Parthenium argentatum</i> Gray): A Rubber-plant of the Chihuahuan Desert (No. 139). Carnegie Institution of Washington, Washington, D.C.	"The whole arrangement would appeal to the teleologist as an excellent adaptation for dissemination by the wind or by water, since the thin, light, and air-imprisoning tissue may serve as wings or floats according to circumstances." ... "The achene measures 2.5 mm. in length by 1.8 in breadth when of normal size, exclusive of the awns." [No evidence, and no means of external attachment, although small size may allow for attachment in mud or soil]

Qsn #	Question	Answer
702	Propagules dispersed intentionally by people	y
	Source(s)	Notes
	USDA, ARS, Germplasm Resources Information Network, 2016. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 20 Apr 2016]	"Cultivated: . also cult"
	WRA Specialist. 2016. Personal Communication	Cultivated as a source of rubber and as a biofuel feedstock

703	Propagules likely to disperse as a produce contaminant	
	Source(s)	Notes
	Tideman,, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"Their tiny seeds are produced at a prolific rate. After a single rainfall, a single plant can yield several thousand seeds. Vigorously growing plants bloom and set seed continuously throughout summer and spring." [No evidence, but the potential exists if cultivation occurs in a large scale in proximity to other crops]

704	Propagules adapted to wind dispersal	y
	Source(s)	Notes
	Fangmeier, D. D., Rubis, D. D., Taylor, B. B., & Foster, K. E. (1984). Guayule for rubber production in Arizona. Technical Bulletin #252. Agricultural Experiment Station, College of Agriculture, University of Arizona, Tucson, AZ	"Because wind and rain can easily shatter seed from the plant, the timing of harvesting is very critical."
	Jorge, M. H. A. (2005). Germination and characterization of guayule (<i>Parthenium argentatum</i> Gray) seed. PhD Dissertation. University of Arizona, Tucson, AZ	"Guayule seed is normally dispersed by shattering (Whitworth & Whitehead, 1991), and the arrangement of the achene complex has adaptations for dissemination by either wind or water. The achene complex is thin, light, and aero dynamic in shape, and thus may serve as wings or help in floating (Lloyd, 1911)."

705	Propagules water dispersed	
	Source(s)	Notes
	Jorge, M. H. A. (2005). Germination and characterization of guayule (<i>Parthenium argentatum</i> Gray) seed. PhD Dissertation. University of Arizona, Tucson, AZ	[Potentially] "Guayule seed is normally dispersed [by shattering (Whitworth & Whitehead, 1991), and the arrangement of the achene complex has adaptations for dissemination by either wind or water. The achene complex is thin, light, and aero dynamic in shape, and thus may serve as wings or help in floating (Lloyd, 1911)."

706	Propagules bird dispersed	n
	Source(s)	Notes
	Jorge, M. H. A. (2005). Germination and characterization of guayule (<i>Parthenium argentatum</i> Gray) seed. PhD Dissertation. University of Arizona, Tucson, AZ	"Guayule seed is normally dispersed by shattering (Whitworth & Whitehead, 1991), and the arrangement of the achene complex has adaptations for dissemination by either wind or water. The achene complex is thin, light, and aero dynamic in shape, and thus may serve as wings or help in floating (Lloyd, 1911)."

707	Propagules dispersed by other animals (externally)	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Lloyd, F. E. (1911). Guayule (<i>Parthenium argentatum</i> Gray): A Rubber-plant of the Chihuahuan Desert (No. 139). Carnegie Institution of Washington, Washington, D.C.	"The whole arrangement would appeal to the teleologist as an excellent adaptation for dissemination by the wind or by water, since the thin, light, and air-imprisoning tissue may serve as wings or floats according to circumstances." ... "The achene measures 2.5 mm. in length by 1.8 in breadth when of normal size, exclusive of the awns." [No evidence, and no means of external attachment, although small size may allow for attachment in mud or soil]

708	Propagules survive passage through the gut	n
	Source(s)	Notes
	Jorge, M. H. A. (2005). Germination and characterization of guayule (<i>Parthenium argentatum</i> Gray) seed. PhD Dissertation. University of Arizona, Tucson, AZ	"Guayule seed is normally dispersed by shattering (Whitworth & Whitehead, 1991), and the arrangement of the achene complex has adaptations for dissemination by either wind or water. The achene complex is thin, light, and aero dynamic in shape, and thus may serve as wings or help in floating (Lloyd, 1911)."

801	Prolific seed production (>1000/m ²)	y
	Source(s)	Notes
	Fangmeier, D. D., Rubis, D. D., Taylor, B. B., & Foster, K. E. (1984). Guayule for rubber production in Arizona. Technical Bulletin #252. Agricultural Experiment Station, College of Agriculture, University of Arizona, Tucson, AZ	"The seeds are small with approximately 450,000 per pound (1,000 seeds per gram)."
	Tideman,, A.F. (1982). The Progress Towards Commercialization of the Guayule plant. (<i>Parthenium argentatum</i>) as a Source of Rubber in the United States of America. Plant Industry Division Report No, 9. Department of Agriculture, South Australia	"Their tiny seeds are produced at a prolific rate. After a single rainfall, a single plant can yield several thousand seeds. Vigorously growing plants bloom and set seed continuously throughout summer and spring."
	Lloyd, F. E. (1911). Guayule (<i>Parthenium argentatum</i> Gray): A Rubber-plant of the Chihuahuan Desert (No. 139). Carnegie Institution of Washington, Washington, D.C.	"Though the maximum number of seeds which may be produced by each capitulum is only 5, the total number yielded by a moderate-sized plant may amount to many thousands. The percentage of viable seed, however, runs small."

802	Evidence that a persistent propagule bank is formed (>1 yr)	
	Source(s)	Notes

Qsn #	Question	Answer
	Bekaardt, C. R., Pieterse, P. J., Coetzee, J. H., & Agenbag, G. A. (2004). The breaking of seed dormancy of guayule (<i>Parthenium argentatum</i> Gray.) by treatment with gibberellic acid and smoke water solution. <i>South African Journal of Plant and Soil</i> , 21(2), 114-116	"Guayule seed exhibits poor germination due to natural dormancy that can last from six- to twelve months after seedset. In an attempt to stimulate seed germination, four guayule seed lines (AZ1 01, AZ-3, N565 and 11591) were treated with smoke water as well as gibberellic acid, both separately and in combination. The split-plot analyses of variance showed no significant interaction between cultivar and treatment factors ($P = 0.71$), but when the time factor was included interaction was highly significant ($P < 0.0001$), indicating that some treatments influenced the rate of germination. Seeds of cultivar AZ-3 treated with the smoke water-gibberellic acid mixture required the shortest number of days for maximum germination to occur. However, treatment of seeds with gibberellic acid resulted in the highest germination of seeds of all four cultivars. These results showed that guayule seed can be stimulated to germinate faster and better by treatment with gibberellic acid and/or smoke water solutions."
	National Academy of Sciences. (1977). <i>Guayule: An Alternative Source of Natural Rubber</i> . NAS, Washington, D.C.	"If stored carefully the seeds can remain viable for several decades; some 20-year-old seed has recently been planted in Israel with over 90 percent germination."
	Naqvi, H. H., & Hanson, G. P. (1982). Germination and growth inhibitors in guayule (<i>Parthenium argentatum</i> Gray) chaff and their possible influence in seed dormancy. <i>American Journal of Botany</i> , 69(6): 985-989.	[Possibly Yes] "During propagation, these freshly harvested seed units show an inherent dormancy, which was attributed to an embryo dormancy of 2 months and a longer-lasting (6-12 months) impermeability of the inner seed coat to gaseous exchange (McCallum, 1929; Ben- edict and Robinson, 1946; Hammond, 1959)."

803	Well controlled by herbicides	
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	Unknown. No information on herbicide efficacy or chemical control of this species

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
	Source(s)	Notes

Qsn #	Question	Answer
	<p>Ray, D. T., Coates, W., Livingston, M., & Garrot, D. J. (1992) Mechanical pollarding as a means to increase rubber yields in guayule (<i>Parthenium argentatum</i>, Asteraceae). <i>Industrial Crops and Products</i>, 1(1), 11-15</p>	<p>[Tolerates pollarding] "Guayule (<i>Parthenium argentatum</i> Gray, Asteraceae) is a potential domestic source of natural rubber, but is presently not competitive economically with imported <i>Hevea</i> rubber. Guayule can become competitive by either increasing rubber yield or reducing the costs of cultural practices, or both. Pollarding, harvesting the branches by cutting leaving the root-crown to regrow new branches, can potentially increase both rubber yields and reduce the costs of stand establishment. The objective of this study was to determine the efficiency of mechanical pollarding, and to determine if there were increased rubber yields one year after pollarding. A mechanical clipper was used to pollard shrub (accession N396), planted at the standard density of 36.650 plants ha. 17 and 29 months after stand establishment. Mechanical pollarding at 17 months left 19% of the branches unclipped on both a fresh and dry weight basis, representing 16% of the potential resin and rubber yield. After regrowth for one year (29 months), pollarded plants had increased fresh weight, dry weight and resin yield over non-pollarded plants of 25, 24 and 15%, respectively. However, rubber yield increased by only 3%, due mainly to the low rubber content in the regrowth. After a single pollarding (17 months) 98% of the plants survived and regenerated new growth. Plants pollarded two consecutive years (17 and 29 months) had only a 66% survival rate. The low rubber yield in the regrowth after one year, and the reduced survival rate of plants pollarded two consecutive years, suggests that a clipping interval of two years may be optimal for line N396."</p>

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	WRA Specialist. 2016. Personal Communication	Unknown

Summary of Risk Traits:

High Risk / Undesirable Traits

- Grows in subtropical-temperate
- Other *Parthenium* species are invasive
- Possibly allelopathic
- Potentially toxic & allergenic sap
- Forms dense stands in parts of native range (although reported to be a poor competitor)
- Reproduces by seeds
- Hybridizes with *Parthenium incanum*
- Apomictic races exist
- May be capable of spreading vegetatively
- Capable of reaching maturity as early as 6 months
- Seeds dispersed by wind, & possibly water
- Intentionally dispersed by people
- Prolific seed production
- Seeds exhibit dormancy & may be capable of forming a persistent seed bank
- Tolerates pollarding (pruning system in which the upper branches are removed, promoting a dense head of foliage and branches)

Low Risk Traits

- No reports of invasiveness or naturalization
- Unarmed (no spines, thorns or burrs)
- Palatable to grazing animals (despite potential toxicity/allergenicity)
- Source of fuel & rubber
- Reportedly intolerant of shade & a poor competitor with other vegetation

Second Screening Results for Tree/tree-like shrubs

(A) Shade tolerant or known to form dense stands?> Not reported to be shade tolerant, but may form dense stands in parts of native range. Unclear whether it is capable of excluding other vegetation

(B) Bird or clearly wind-dispersed?> Yes. Wind

(C) Life cycle <4 years? Yes. Reproduces as early as 6 months

Outcome = Evaluate Further

TAXON: *Parthenium argentatum* A.
Gray

SCORE: 5.0

RATING: Evaluate