Taxon: Tithonia diversifolia (Hemsl.) A. Gray **Family:** Asteraceae

Common Name(s): Japanese sunflower
Mexican sunflower
Mexican sunflower weed
shrub sunflower
tree marigold

Synonym(s): Mirasolia diversifolia Hemsl.

Assessor: No Assessor **Status:** Assessor Approved **End Date:** 8 Jun 2018

WRA Score: **23.0** **Designation:** H(HPWRA) **Rating:** High Risk

Keywords: Ornamental Shrub, Crop Weed, Allelopathic, Dense Stands, 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	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?		
301	Naturalized beyond native range	y = 1*multiplier (see Appendix 2), n= question 205	y
302	Garden/amenity/disturbance weed	n=0, y = 1*multiplier (see Appendix 2)	y
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	y
304	Environmental weed		
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	y=1, n=0	n
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n

Qsn #	Question	Answer Option	Answer
408	Creates a fire hazard in natural ecosystems		
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	n
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y=1, n=0	y
411	Climbing or smothering growth habit	y=1, n=0	n
412	Forms dense thickets	y=1, n=0	y
501	Aquatic	y=5, n=0	n
502	Grass	y=1, n=0	n
503	Nitrogen fixing woody plant	y=1, n=0	n
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	y=1, n=0	n
601	Evidence of substantial reproductive failure in native habitat	y=1, n=0	n
602	Produces viable seed	y=1, n=-1	y
603	Hybridizes naturally		
604	Self-compatible or apomictic		
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	y=1, n=-1	y
607	Minimum generative time (years)	1 year = 1, 2 or 3 years = 0, 4+ years = -1	1
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y=1, n=-1	y
702	Propagules dispersed intentionally by people	y=1, n=-1	y
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	y
704	Propagules adapted to wind dispersal	y=1, n=-1	y
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		
801	Prolific seed production (>1000/m2)	y=1, n=-1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)		
803	Well controlled by herbicides	y=-1, n=1	y
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**
	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 of domestication] "Native to Mexico, naturalized in many tropical countries;"

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"**	**High**
	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 7 Jun 2018]	"Native Northern America NORTHERN MEXICO: Mexico [Sinaloa] SOUTHERN MEXICO: Mexico [Campeche, Chiapas, Guerrero, Michoacan, Oaxaca, Quintana Roo, Tabasco, Veracruz, Yucatan] Southern America CENTRAL AMERICA: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama"

202	**Quality of climate match data**	**High**
	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 7 Jun 2018]	

203	**Broad climate suitability (environmental versatility)**	**y**
	Source(s)	**Notes**
	Floridata. 2018. Tithonia diversifolia. https://floridata.com/Plants/Asteraceae/Tithonia%20diversifolia/1098. [Accessed 7 Jun 2018]	"Hardiness: USDA Zones 9 - 11. Light frosts and freezes will kill Bolivian sunflowers to the ground, but if the damage isn't too bad, they come back in spring. Some people have had success with this tropical in Zone 8. In frost free climates, this sunflower can achieve the proportions of a small house."

Qsn #	Question	Answer
	Dave's Garden. 2018. Tithonia Species, Mexican Sunflower, Bolivian Sunflower, Marigold Tree - Tithonia diversifolia. https://davesgarden.com/guides/pf/go/59827/. [Accessed 7 Jun 2018]	"Hardiness: USDA Zone 9a: to -6.6 °C (20 °F) USDA Zone 9b: to -3.8 °C (25 °F) USDA Zone 10a: to -1.1 °C (30 °F) USDA Zone 10b: to 1.7 °C (35 °F)"
	Tropicos.org. 2018. Missouri Botanical Garden. http://www.tropicos.org/. [Accessed]	Collected from 0 - 30 m, 16°24'00"N to 2800 m, 15°30'35"N [Occupies an elevation range >2000 m, demonstrating environmental versatility]

204	**Native or naturalized in regions with tropical or subtropical climates**	**y**
	Source(s)	**Notes**
	Wagner, W.L., Herbst, D.R.& Sohmer, S.H. 1999. Manual of the flowering plants of Hawaii. Revised edition. University of Hawai'i Press and Bishop Museum Press, Honolulu, HI.	"Native to Mexico, naturalized in many tropical countries; in Hawai'i originally grown as an ornamental, now naturalized in low elevation sites on Kaua'i, O'ahu, Maui, and Hawai'i."

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 7 Jun 2018]	"Native Northern America NORTHERN MEXICO: Mexico [Sinaloa] SOUTHERN MEXICO: Mexico [Campeche, Chiapas, Guerrero, Michoacan, Oaxaca, Quintana Roo, Tabasco, Veracruz, Yucatan] Southern America CENTRAL AMERICA: Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama Cultivated (cult. throughout tropics & subtropics) Adventive Africa MACARONESIA: Spain [Canary Islands] Naturalized Africa NORTHEAST TROPICAL AFRICA: Chad, Ethiopia EAST TROPICAL AFRICA: Kenya, Tanzania, Uganda WEST-CENTRAL TROPICAL AFRICA: Burundi, Cameroon, Central African Republic, Rwanda, Zaire WEST TROPICAL AFRICA: Cote D'Ivoire, Guinea, Nigeria, Togo SOUTH TROPICAL AFRICA: Malawi, Mozambique, Zambia, Zimbabwe SOUTHERN AFRICA: South Africa, [KwaZulu-Natal, Limpopo] Swaziland WESTERN INDIAN OCEAN: Mauritius, Mayotte, Reunion Asia-Temperate CHINA: China [Guangdong, Yunnan] EASTERN ASIA: Taiwan Asia-Tropical INDIAN SUBCONTINENT: India, Nepal, Sri Lanka PAPUASIA: Papua New Guinea INDO-CHINA: Myanmar, Thailand MALESIA: Malaysia, Philippines Australasia AUSTRALIA: Australia [New South Wales, Queensland] Northern America SOUTHEASTERN U.S.A.: United States [Florida] SOUTH-CENTRAL U.S.A.: United States [Texas] Pacific NORTH-CENTRAL PACIFIC: United States [Hawaii] SOUTH-CENTRAL PACIFIC: Cook Islands, French Polynesia SOUTHWESTERN PACIFIC: Fiji, New Caledonia, Niue, Samoa, Tonga, Vanuatu Southern America CARIBBEAN: Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Grenada, Guadeloupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, St. Kitts and Nevis, St. Lucia, St. Vincent and Grenadines, Trinidad and Tobago, [Trinidad] Virgin Islands (British) [Tortola] NORTHERN SOUTH AMERICA: Venezuela BRAZIL: Brazil WESTERN SOUTH AMERICA: Colombia, Ecuador [Galapagos Islands] SOUTHERN SOUTH AMERICA: Chile [Easter Island]"

Qsn #	Question	Answer
205	**Does the species have a history of repeated introductions outside its natural range?**	
	Source(s)	**Notes**
	Ayeni, A. O., Lordbanjou, D. T., & Majek, B. A. (1997). Tithonia diversifolia (Mexican sunflower) in south-western Nigeria: occurrence and growth habit. Weed Research, 37 (6), 443-449	"In the 1960s. T. diversifolia was introduced from Central America into the farm settlement schemes of the then Western Nigeria. covering what is now Lagos. Ogun. Ondo, Osun and Oyo states. as a source of green manure (Akobundu & Agyakwa, 1987; Anonymous, 1994; Ayeni et al. 1997)."
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"In West Africa, Tithornia diversifolia has been reported to be introduced as an ornamental plant [1] and with imported grains [11]."
	Yang, J., Tang, L., Guan, Y., & Sun, W. (2012). Genetic Diversity of an Alien Invasive Plant Mexican Sunflower (Tithonia diversifolia) in China. Weed Science, 60(4), 552-557	"Mexican sunflower, native to North and Central America, has been widely introduced to Asia, Africa, America, and Australia for ornamental use, green manure, and erosion control, but now has been reported to be naturalized and aggressively invading in Southeast Asia, South Africa, and the Pacific region (Henderson 2001; Lazarides et al. 1997; Meyer 2000; Varnham 2006; Xu et al. 2007)."
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"Two species of the genus Tithonia A. L. Jussieu, native to Mexico and Central America, are grown here as ornamentals. The more common of the two is Tithonia diversifolia (W. Hemsley) A . Gray,"... "Mexican-sunflower has escaped to become a naturalized weed in Hawai'i and many tropical and warm countries in the Old World."

301	**Naturalized beyond native range**	**y**
	Source(s)	**Notes**
	Yang, J., Tang, L., Guan, Y., & Sun, W. (2012). Genetic Diversity of an Alien Invasive Plant Mexican Sunflower (Tithonia diversifolia) in China. Weed Science, 60(4), 552-557	"Mexican sunflower is a native species of North and Central America that was introduced into China early last century, but it has widely naturalized and become a harmful invasive plant in tropical and subtropical regions in South China."
	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 Mexico, naturalized in many tropical countries; in Hawai'i originally grown as an ornamental, now naturalized in low elevation sites on Kaua'i, O'ahu, Maui, and Hawai'i. First collected on Hawai'i in 1917 (Rock 12964, BISH)."

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 7 Jun 2018]	"Naturalized Africa NORTHEAST TROPICAL AFRICA: Chad, Ethiopia EAST TROPICAL AFRICA: Kenya, Tanzania, Uganda WEST-CENTRAL TROPICAL AFRICA: Burundi, Cameroon, Central African Republic, Rwanda, Zaire WEST TROPICAL AFRICA: Cote D'Ivoire, Guinea, Nigeria, Togo SOUTH TROPICAL AFRICA: Malawi, Mozambique, Zambia, Zimbabwe SOUTHERN AFRICA: South Africa, [KwaZulu-Natal, Limpopo] Swaziland WESTERN INDIAN OCEAN: Mauritius, Mayotte, Reunion Asia-Temperate CHINA: China [Guangdong, Yunnan] EASTERN ASIA: Taiwan Asia-Tropical INDIAN SUBCONTINENT: India, Nepal, Sri Lanka PAPUASIA: Papua New Guinea INDO-CHINA: Myanmar, Thailand MALESIA: Malaysia, Philippines Australasia AUSTRALIA: Australia [New South Wales, Queensland] Northern America SOUTHEASTERN U.S.A.: United States [Florida] SOUTH-CENTRAL U.S.A.: United States [Texas] Pacific NORTH-CENTRAL PACIFIC: United States [Hawaii] SOUTH-CENTRAL PACIFIC: Cook Islands, French Polynesia SOUTHWESTERN PACIFIC: Fiji, New Caledonia, Niue, Samoa, Tonga, Vanuatu Southern America CARIBBEAN: Antigua and Barbuda, Bahamas, Barbados, Cuba, Dominica, Grenada, Guadeloupe, Hispaniola, Jamaica, Martinique, Montserrat, Puerto Rico, St. Kitts and Nevis, St. Lucia, St. Vincent and Grenadines, Trinidad and Tobago, [Trinidad] Virgin Islands (British) [Tortola] NORTHERN SOUTH AMERICA: Venezuela BRAZIL: Brazil WESTERN SOUTH AMERICA: Colombia, Ecuador [Galapagos Islands] SOUTHERN SOUTH AMERICA: Chile [Easter Island]"
	Oppenheimer, H. 2013. New Hawaiian plant records for 2012. Bishop Museum Occasional Papers 114: 17–20	"Originally grown in Hawai`i as an ornamental, now naturalized in low elevation sites on Kaua‘i, O‘ahu, Maui, and Hawai‘i islands (Wagner et al. 1999: 370), tree marigold was recently collected outside of cultivation on Lāna‘i. Material examined. LĀNA‘I: Lāna‘i City, south end of Queens Street, 500 m, naturalized, forming small patches and scattered plants in overgrown grassy area, 28 Nov 2012, Oppenheimer & Perlman H111230."
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Recently two species, Tithonia diversifolia and Tithonia rotundifolia, of the 11 species of the genus Tithonia, native to North and Central America have been introduced, are naturalized and have become invasive species in Africa. These two species have become naturalized in Southern Africa while Tithonia diversifolia has naturalized in West Africa."

Qsn #	Question	Answer
302	**Garden/amenity/disturbance weed**	**y**
	Source(s)	**Notes**
	Hyde, M.A., Wursten, B.T., Ballings, P. & Coates Palgrave, M. 2018. Flora of Zimbabwe: Species information: Tithonia diversifolia. https://www.zimbabweflora.co.zw/speciesdata/species.php?species_id=160460. [Accessed 8 Jun 2018]	"A weed of roadsides and waste places"
	Yang, J., Tang, L., Guan, Y., & Sun, W. (2012). Genetic Diversity of an Alien Invasive Plant Mexican Sunflower (Tithonia diversifolia) in China. Weed Science, 60(4), 552-557	"Field observations revealed that Mexican sunflower can adapt to multiple habitats such as roadsides, river banks, disturbed or abandoned sites, and sun-exposed ecosystems, and can invade fields around farmlands, nursery gardens, and banana orchards."
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Recently two species, Tithonia diversifolia and Tithonia rotundifolia, of the 11 species of the genus Tithonia, native to North and Central America have been introduced, are naturalized and have become invasive species in Africa. These two species have become naturalized in Southern Africa while Tithonia diversifolia has naturalized in West Africa. In these areas, the species have established themselves as serious weeds of arable crops, plantations, abandoned lawns and roadsides. They are aggressive colonizers of new sites, colonizing every available sunny space with high water table."
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"T. diversifolia, commonly known as the tree marigold, is a herbaceous flowering plant in the Asteraceae family. Native to Mexico and Central America, it has been introduced and is now naturalized in tropical parts of Asia and Africa. It is also naturalized in some Pacific islands, where it is found along roadsides and in disturbed areas."

Qsn #	Question	Answer
303	**Agricultural/forestry/horticultural weed**	**y**
	Source(s)	**Notes**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Farmers can lose a lot of money controlling T. diversifolia in their crop fields. The plant also destroys grazing land for domestic animals."
	Ayeni, A. O., Lordbanjou, D. T., & Majek, B. A. (1997). Tithonia diversifolia (Mexican sunflower) in south-western Nigeria: occurrence and growth habit. Weed Research, 37 (6), 443-449	"Little information is available on this plant in Nigeria, but the vast agricultural land area it already occupies plus the fact that it has forced many farmers to abandon their farm land in southwestern Nigeria has become a major concern to weed scientists in the country."
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Recently two species, Tithonia diversifolia and Tithonia rotundifolia, of the 11 species of the genus Tithonia, native to North and Central America have been introduced, are naturalized and have become invasive species in Africa. These two species have become naturalized in Southern Africa while Tithonia diversifolia has naturalized in West Africa. In these areas, the species have established themselves as serious weeds of arable crops, plantations, abandoned lawns and roadsides. They are aggressive colonizers of new sites, colonizing every available sunny space with high water table."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Weed of: Cereals, Orchards & Plantations, Sunflowers"

304	**Environmental weed**	
	Source(s)	**Notes**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Areas highly infested by T. divesifolia experience a reduction in biodiversity since grass species growing beneath it are destroyed due to the allelopathic effect of the plant."
	Simelane, D. O., Mawela, K. V., & Fourie, A. (2011). Prospective agents for the biological control of Tithonia rotundifolia (Mill.) SF Blake and Tithonia diversifolia (Hemsl.) A. Gray (Asteraceae) in South Africa. African Entomology, 19(2), 443-450	[Potentially] "The increasing abundance of T. rotundifolia and T. diversifolia in conservation and agricultural areas over the past ten years in South Africa has been of concern, resulting in the initiation of a biological control programme against these two species in 2007."
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	[Primarily regarded as an agricultural weed, but may also impact native species] "Because of the rate these species are spreading, colonizing every available open space especially along roadsides and displacing the native species in areas where they occur, this study was carried out to investigate the reproductive strategy and seed germination of these Tithonia species occurring in Africa with the aim of determining the characteristics responsible for their invasive habits."

305	**Congeneric weed**	**y**
	Source(s)	**Notes**

Qsn #	Question	Answer
	Simelane, D. O., Mawela, K. V., & Fourie, A. (2011). Prospective agents for the biological control of Tithonia rotundifolia (Mill.) SF Blake and Tithonia diversifolia (Hemsl.) A. Gray (Asteraceae) in South Africa. African Entomology, 19(2), 443-450	"The increasing abundance of T. rotundifolia and T. diversifolia in conservation and agricultural areas over the past ten years in South Africa has been of concern, resulting in the initiation of a biological control programme against these two species in 2007."
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Tithonia rotundifolia Is an invasive weed in parts of Africa. T. rotundifolia is a serious weed of arable crops, plantations, abandoned lawns and roadsides. It is an aggressive colonizer of new sites that have high light and adequate moisture."

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] "Shrubs 2-5 m tall, wood very soft, villous and aromatic glandular to subglabrate. Leaves palmately 3-5-lobed, blades 8-15 (-22) cm long, 6-10(-12) cm wide, gradually tapering to a petiole 2-4 cm long."

402	Allelopathic	y
	Source(s)	**Notes**
	Baruah, N. C., Sarma, J. C., Barua, N. C., Sarma, S., & Sharma, R. P. (1994). Germination and growth inhibitory sesquiterpene lactones and a flavone from Tithonia diversifolia. Phytochemistry, 36(1), 29-36	"Inhibitory effects of two sesquiterpene lactones tagitinin A, tagitinin C and a flavonoid hispidulin isolated from Tithonia diversifolia were determined on germination of radish, cucumber and onion seeds. The flavonoid hispidulin was more toxic to the crop seeds tested and the activity of tagitinin C was weaker than that of tagitinin A and hispidulin. Seventeen derivatives have been prepared from tagitinin A and C by chemical transformation and their phytotoxicity has been compared with the parent compounds (all at 250,µM) using radish seeds. The structural requirements related to their biological activity have also been delineated."
	Tongma, S., Kobayashi, K., & Usui, K. (1998). Allelopathic activity of Mexican sunflower (Tithonia diversifolia) in soil. Weed Science, 46(4): 432-437	"The results of the present study indicate that soil planted with Mexican sunflower or treated with water extract from Mexican sunflower leaves, soil-water separated from planted soil, or leaf residue has phytotoxic activity on the growth of a number of plants. This indicates that Mexican sunflower has allelopathic potential. It also can be concluded that the phytotoxic activity of Mexican sunflower extract and residue in soil is affected by soil factors, such as soil microorganisms and adsorption, and that the phytotoxic activity depends on the amount of inhibitory substances contained in the soil- water."

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 2-5 m tall, wood very soft, villous and aromatic glandular to subglabrate." [Asteraceae. No evidence]

404	Unpalatable to grazing animals	n

Qsn #	Question	Answer
	Source(s)	**Notes**
	Akinola, J. O., Larbi, A., Farinu, G. O., & Odunsi, A. A. (2000). Seed treatment methods and duration effects on germination of wild sunflower. Experimental Agriculture, 36(1), 63-69	"In south-western Nigeria, Tithonia diversifolia is browsed by nomadic and village cattle, sheep and goats."
	Perera, A. N. F., & Perera, E. R. K. (2006). Evaluation of lesser-known feeds for ruminants to improve and sustain animal productivity during dry periods. In: Improving Animal Productivity by Supplementary Feeding of Multinutrient Blocks, Controlling Internal Parasites and Enhancing Utilization of Alternate Feed Resources. IAEA, Vienna, Austria	"Tree forages are regarded as important in Sri Lanka. Tithonia diversifolia is one of the major non-leguminous forages used by the Mid-country farmers, together with Panicum maximum grass, to feed their cattle." … "Tithonia diversifolia and A. indica have benefits beyond their nutritional value when fed to ruminants, in that they contain anthelmintic properties for the control of internal parasites [13]."
	Floridata. 2018. Tithonia diversifolia. https://floridata.com/Plants/Asteraceae/Tithonia%20diversifolia/1098. [Accessed 8 Jun 2018]	"Unfortunately, I can't grow Bolivian sunflower in my yard because the squirrels and the deer eat them to the ground. The white-tailed deer eat the leaves, and the gray squirrels eat the stems. Even pieces of stem that I tried to start in nursery pots and hid behind the greenhouse were discovered and eaten by the squirrels. Researching this article, I learned that Tithonia diversifolia leaves and stems are particularly high in nutrients (especially N, P and K) and are used as fertilizer in tropical regions. I guess the squirrels already knew that."

405	Toxic to animals	n
	Source(s)	**Notes**
	Akinola, J. O., Larbi, A., Farinu, G. O., & Odunsi, A. A. (2000). Seed treatment methods and duration effects on germination of wild sunflower. Experimental Agriculture, 36(1), 63-69	"In south-western Nigeria, Tithonia diversifolia is browsed by nomadic and village cattle, sheep and goats."
	Perera, A. N. F., & Perera, E. R. K. (2006). Evaluation of lesser-known feeds for ruminants to improve and sustain animal productivity during dry periods. In: Improving Animal Productivity by Supplementary Feeding of Multinutrient Blocks, Controlling Internal Parasites and Enhancing Utilization of Alternate Feed Resources. IAEA, Vienna, Austria	[No evidence] "Tree forages are regarded as important in Sri Lanka. Tithonia diversifolia is one of the major non leguminous forages used by the Mid-country farmers, together with Panicum maximum grass, to feed their cattle."
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	No evidence

406	Host for recognized pests and pathogens	
	Source(s)	**Notes**

Qsn #	Question	Answer
	Fernandes, A. D. F., de Miranda, B. E., Duarte, L. L., & Barreto, R. W. (2013). Passalora stromatica sp. nov. associated with leaf spots of Tithonia diversifolia in Brazil. IMA fungus, 4(2), 201-204	"Tithonia diversifolia, a member of Compositae native to Central America that produces showy sunflower-like flowers, became an invasive weed in other continents after it was introduced as an ornamental. Little is known about fungal pathogens infecting this plant. Knowledge of its mycobiota is of interest for future biocontrol programmes for T. diversifolia. In Brazil, a cercosporoid hyphomycete was found associated with intense leaf-spotting of this plant. Based on morphological and molecular data it was recognized as representing a new species of Passalora, and the name Passalora stromatica sp.nov. is introduced here for this taxon. This fungus is described and illustrated herein. It is possible that this fungus is playing a role in Brazil in reducing the invasiveness of T. diversifolia as, contrarily to what has been reported for countries in Africa and Asia, it remains mostly as a garden escape or rural plant in Brazil."
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	No evidence provided

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	**Notes**
	Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	[No evidence. Medicinal uses] "Used orally to treat malaria and other forms of fever and topically to treat hematomas and muscular cramps, also used as a liniment. Flower heads for wounds and bruises. Leaf juice or whole plant a remedy for gastrointestinal complaints, acidity, an antiinflammatory, a treatment for wounds and skin eruptions; leaves ground with those of Bidens pilosa and the paste applied all over the body against the fever. Leaves infusion drunk for stomachache, leaves also heated over fire and placed on sore stomach."
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence
	NIH U.S. National Library of Medicine. 2018. TOXNET Toxicology Data Network. https://toxnet.nlm.nih.gov/. [Accessed 8 Jun 2018]	No evidence

408	Creates a fire hazard in natural ecosystems	
	Source(s)	**Notes**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	Unknown. Not listed among potential impacts

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	**Notes**
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"...aggressive colonizers of new sites, colonizing every available sunny space with high water table."

Qsn #	Question	Answer
	Floridata. 2018. Tithonia diversifolia. https://floridata.com/Plants/Asteraceae/Tithonia%20diversifolia/1098. [Accessed 8 Jun 2018]	"Light: Sunflowers need full sun."
	Dave's Garden. 2018. Tithonia Species, Mexican Sunflower, Bolivian Sunflower, Marigold Tree - Tithonia diversifolia. https://davesgarden.com/guides/pf/go/59827/. [Accessed 8 Jun 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**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"'Soil drainage free Soil texture light medium Special soil tolerances infertile"
	Etejere, E. O., & Olayinka, B. U. (2014). Seed Production, Germination, Emergence and Growth of Tithonia diversifolia (Hemsl.) A. Gray as Influenced by Different Sowing Depths and Soil Types. American-Eurasian J. Agric. & Environ. Sci., 14(5): 440-444	"T. diversifolia was found to thrive in all the soil types studied. This further explains the ability of this plant to grow on a wide variety of ecological habitats."

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 2-5 m tall, wood very soft, villous and aromatic glandular to subglabrate."

412	Forms dense thickets	y
	Source(s)	**Notes**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Field observations indicated that T. diversifolia has a great capacity to grow clonally. The clonal growth is especially common during rainy reason, when adventitious roots and young shoots rapidly emerge from nodes on lower or prostrate branches and clonal growth contributes to extensive horizontal expansion of patches, which together leads to the creation of dense stands."
	Witt, A. (2017). Guide to the naturalized and invasive plants of Southeast Asia. CABI, Wallingford	"Forms dense stands displacing native plant species and the animals associated with them."

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] "Shrubs 2-5 m tall, wood very soft, villous and aromatic glandular to subglabrate." … "in Hawai'i originally grown as an ornamental, now naturalized in low elevation sites on Kaua'i, O'ahu, Maui, and Hawai'i."

502	Grass	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 7 Jun 2018]	Family: Asteraceae (alt.Compositae)

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 7 Jun 2018]	Family: Asteraceae (alt.Compositae)

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.	"Shrubs 2-5 m tall, wood very soft, villous and aromatic glandular to subglabrate."

601	Evidence of substantial reproductive failure in native habitat	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 8 Jun 2018]	No evidence. Broad native & introduced ranges

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.	"Achenes flattened, ca. 5 mm long, pubescent."

Qsn #	Question	Answer
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"It is concluded that small sized light and numerous seeds produced by Tithonia diversifolia accounts for its wide dispersal and rapid spread in colonized areas. Also its perennial habit and ability to reproduce sexually and vegetatively accounts for the species colonizing and stabilizing fast in new habitats."
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"The plant flowers and produces seeds throughout the year. Typically mature plants produce 80,000 to 160,000 seeds per square meter annually, 70% of which fully develop."

603	Hybridizes naturally	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	Unknown. No evidence found

604	Self-compatible or apomictic	
	Source(s)	**Notes**
	Yang, J., Tang, L., Guan, Y., & Sun, W. (2012). Genetic Diversity of an Alien Invasive Plant Mexican Sunflower (Tithonia diversifolia) in China. Weed Science, 60(4), 552-557	"Although the breeding system of Mexican sunflower has not been extensively studied, the high within-population genetic diversity and lower levels of genetic diversity among populations implies outcrossing in this species (Hamrick and Godt 1996)."
	Noyes, R. D. 2007. Apomixis in the Asteraceae: diamonds in the rough. Functional Plant Science and Biotechnology, 1(2): 207-222	[Apomixis documented in genus] "Apomixis is recorded for 15 new taxa, including apospory for seven genera (Ageratum, Calendula, Carthamus, Eurybia, Hypochaeris, Melampodium, Tithonia) and diplospory for eight genera (Ayapana, Blumea, Chromolaena, Eupatorium, Laggera, Leontopodium, Scorzonera, Townsendia), yielding a total of 39 genera in 12 tribes."

605	Requires specialist pollinators	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.	"Heads large and showy; ray florets 7-21 per head, rays yellow, 3-6 cm long; disk florets numerous, corollas ca. 15 mm long" [Flowers adapted for insect pollination]
	Luvonga, E. B. (2015). Diversity and pollination activity of flower visiting insects associated with avocado along the slopes of Taita hills in Kenya. MSc Thesis. Masinde Muliro University of Science and Technology	"Tithonia diversifolia, Monechma debile and Euryops chrysanthemoides hosted honeybees, small carpenter bee (Ceratina sp.) and Lasioglossum sp. during the rainy season while Ocimum gratissimum was highly preferred by honeybees, reed bees (Braunsapis sp.), small carpenter bees (Ceratina sp.) and sweat bees (Lasioglossum sp.) during the dry season."

606	Reproduction by vegetative fragmentation	y
	Source(s)	**Notes**
	Floridata. 2018. Tithonia diversifolia. https://floridata.com/Plants/Asteraceae/Tithonia%20diversifolia/1098. [Accessed 7 Jun 2018]	"The easiest way to start a new Bolivian sunflower is just to take a piece of stem, say 10 in (25 cm) long and an inch (2.5 cm) or so in diameter, and stick it in the ground. Don't water too much, and it should start producing roots and new leaves in a few days."

Qsn #	Question	Answer
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Tithonia rotundifolia reproduces from only seeds while Tithonia diversifolia reproduces from seeds and vegetative regrowth of basal stem when the plant is slashed." … "T. diversifolia perennial habit and the ability to reproduce sexually and vegetatively may account for the species colonizing new habitats and stabilizing fast in colonized sites. The plant coppices profusely when the stem is cut. Vegetative reproduction allows it to occupy a temporary site quickly while light seeds produced by sexual reproduction allow distance dispersal to new sites."

607	Minimum generative time (years)	1
	Source(s)	**Notes**
	Witt, A. (2017). Guide to the naturalized and invasive plants of Southeast Asia. CABI, Wallingford	"Annual or evergreen herbaceous shrub, woody at the base [2–3 (–5) m high]; stems slightly ridged and hairy when young."
	Ayeni, A. O., Lordbanjou, D. T., & Majek, B. A. (1997). Tithonia diversifolia (Mexican sunflower) in south-western Nigeria: occurrence and growth habit. Weed Research, 37 (6), 443-449	"T. diversifolia is an annual/perennial broad-leaved plant. In an undisturbed environment and under upland conditions, the plant behaves as an annual. but frequent slashing encourages vigorous branching at the basal nodes, which turns the plant into a perennial shrub. In addition, at valley bottom sites, where the water table is high. T. diversifolia behaves as a perennial"

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	**Notes**
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Movement within the country may involve natural dispersal (by wind or water), animal movements (native, domestic and feral animals disperse the seeds), vehicles, transport of soils and agricultural products and so on."
	Witt, A. (2017). Guide to the naturalized and invasive plants of Southeast Asia. CABI, Wallingford	"Roadsides, disturbed sites, wastelands, urban open space, fallow land, savannah, lowlands and riparian vegetation." [Invades heavily trafficked areas]

702	Propagules dispersed intentionally by people	y
	Source(s)	**Notes**
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"Humans and livestock can carry T. diversifolia seeds over large distances."
	Staples, G.W. & Herbst, D.R. 2005. A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places. Bishop Museum Press, Honolulu, HI	"Two species of the genus Tithonia A. L. Jussieu, native to Mexico and Central America, are grown here as ornamentals. The more common of the two is Tithonia diversifolia (W. Hemsley) A . Gray,"… "Mexican-sunflower has escaped to become a naturalized weed in Hawai'i and many tropical and warm countries in the Old World."

703	Propagules likely to disperse as a produce contaminant	y
	Source(s)	**Notes**

Qsn #	Question	Answer
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Movement within the country may involve natural dispersal (by wind or water), animal movements domestic and feral animals disperse the seeds), vehicles, transport of soils and agricultural products and so on."
	Chukwuka, K. S., Ogunyemi, S., & Fawole, I. (2007). Ecological distribution of Tithonia diversifolia (Hemsl). A. Gray—a new exotic weed in Nigeria. Journal of Biological Science, 7(5), 709-719	"T. diversifolia is thought to have been introduced to Nigeria as a produce contaminant in seeds of Zea mays imported from Israel."
	Sangakkara, U. R., Liedgens, M., Soldati, A., & Stamp, P. (2004). Root and shoot growth of maize (Zea mays) as affected by incorporation of Crotalaria juncea and Tithonia diversifolia as green manures. Journal of Agronomy and Crop Science, 190(5), 339-346	"Tithonia diversifolia is used as a green manure in Africa and Asia. This species has the ability to mine phosphorus from the soil and provide this element for crop growth."

704	Propagules adapted to wind dispersal	y
	Source(s)	**Notes**
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Movement within the country may involve natural dispersal (by wind or water), animal movements (native, domestic and feral animals disperse the seeds), vehicles, transport of soils and agricultural products and so on."
	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.	"Pappus of 2 persistent awns ca. 5 mm long. Achenes flattened, ca. 5 mm long."
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"The pubescent seed with a pappus can be dispersed by wind, and can also be carried over large areas by water currents."

705	Propagules water dispersed	y
	Source(s)	**Notes**
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Movement within the country may involve natural dispersal (by wind or water), animal movements (native, domestic and feral animals disperse the seeds), vehicles, transport of soils and agricultural products and so on."

706	Propagules bird dispersed	n
	Source(s)	**Notes**
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	[No evidence] "Movement within the country may involve natural dispersal (by wind or water), animal movements (native, domestic and feral animals disperse the seeds), vehicles, transport of soils and agricultural products and so on."

Qsn #	Question	Answer
707	**Propagules dispersed by other animals (externally)**	**y**
	Source(s)	**Notes**
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Movement within the country may involve natural dispersal (by wind or water), animal movements domestic and feral animals disperse the seeds), vehicles, transport of soils and agricultural products and so on."

708	**Propagules survive passage through the gut**	
	Source(s)	**Notes**
	WRA Specialist. 2018. Personal Communication	Unknown. Consumed by animals as fodder, but unknown if seeds are intentionally or accidentally consumed, and whether or not they survive gut passage

801	**Prolific seed production (>1000/m2)**	**y**
	Source(s)	**Notes**
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"Table 1. Summary of reproductive tissues production at peak growth of Tithonia diversifolia and Tithonia rotundifolia. Values are means and ±95 % confidence interval." [Tithonia diversifolia produces 134,451.75±49,792.14 seeds per plant]
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"The plant flowers and produces seeds throughout the year. Typically mature plants produce 80,000 to 160,000 seeds per square meter annually, 70% of which fully develop."

802	**Evidence that a persistent propagule bank is formed (>1 yr)**	
	Source(s)	**Notes**
	Royal Botanic Gardens Kew. (2018) Seed Information Database (SID). Version 7.1. Available from: http://data.kew.org/sid/. [Accessed 8 Jun 2018]	"Storage Conditions: Long-term storage under IPGRI preferred conditions at RBG Kew, WP. Oldest collection 8 years"
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	[Exhibits dormancy. Longevity in soil unspecified] "It is concluded from this study that some of the characteristics contributing to invasive habits of Tithonia diversifolia and Tithonia rotundifolia are seed dormancy in both species, small sized light and numerous seeds production and sexual and vegetative reproduction of T. diversifolia and large sized seeds and high reproductive allocation of T. rotundifolia."

803	**Well controlled by herbicides**	**y**
	Source(s)	**Notes**
	Ayeni, A. O., Agbato, S. O., & Majek, B. A. (1997). Seed depth influence on Mexican sunflower (Tithonia diversifolia) emergence and control. Weed Technology, 11 417-427	"In this field experiment, a preemergence application of imazethapyr-pendimethalin mixture at 0.09 + 1.31 kg/ha (equivalent to 4L/ha commercial product) was an effective control of Tithonia diversifolia."
	CABI. 2018. Invasive Species Compendium. Wallingford , UK: CAB International. www.cabi.org/isc	"T. diversifolia can be dug out when numbers are low. Slashing can result in re-sprouting from uncut stumps. Suitable herbicides can be applied as a foliar spray or a spot spray."

Qsn #	Question	Answer
	WRA Specialist. 2018. Personal Communication	[Several herbicides are recommended for control of this species] "Aminopyralid + Metsulfuron Aminopyralid (375g/kg) + Metsulfuron (300g/kg) 0.075g + 0.06g/L water + wetter Foliar Triclopyr + Picloram + Aminopyralid Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L) 1.05g + 0.35g + 0.028g/L water Foliar; Metsulfuronmethyl Metsulfuron-methyl (600g/kg) 0.06g/L water + wetter Foliar

804	Tolerates, or benefits from, mutilation, cultivation, or fire	y
	Source(s)	**Notes**
	Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of Tithonia diversifolia (Hemsl.) Gray and Tithonia rotundifolia (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46	"T. diversifolia perennial habit and the ability to reproduce sexually and vegetatively may account for the species colonizing new habitats and stabilizing fast in colonized sites. The plant coppices profusely when the stem is cut. Vegetative reproduction allows it to occupy a temporary site quickly while light seeds produced by sexual reproduction allow distance dispersal to new sites."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	**Notes**
	Simelane, D. O., Mawela, K. V., & Fourie, A. (2011). Prospective agents for the biological control of Tithonia rotundifolia (Mill.) SF Blake and Tithonia diversifolia (Hemsl.) A. Gray (Asteraceae) in South Africa. African Entomology, 19(2), 443-450	[Unknown for the Hawaiian Islands] "Starting in 2007, two weedy sunflower species, Tithonia rotundifolia (Mill.) S.F.Blake and Tithonia diversifolia (Hemsl.) A.Gray (Asteraceae: Heliantheae), were targeted for biological control in SouthAfrica. Surveys conducted in their native range (Mexico) revealed that there were five potential biological control agents forT. rotundifolia, and three of these are currently undergoing host-specificity and performance evaluations in South Africa. Two leaf-feeding beetles, Zygogramma signatipennis (Stål) and Zygogramma piceicollis (Stål) (Coleoptera: Chrysomelidae), are the most promising biological control agents for T. rotundifolia: preliminary host-specificity trials suggest that they are adequately host-specific. The stem-boring beetle, Lixus fimbriolatus Boheman (Coleoptera: Curculionidae), is also highly damaging to T. rotundifolia, but its host range is yet to be determined. Two other stem-boring beetles, Canidia mexicana Thomson (Coleoptera: Cerambycidae) and Rhodobaenus auctus Chevrolat (Coleoptera: Curculionidae), have also been recorded on T. rotundifolia, and these will be considered for further testing if L. fimbriolatus is found to be unsuitable for release in South Africa. Only two insect species were imported as candidate agents on T. diversifolia, the leaf-feeding butterfly Chlosyne sp. (Lepidoptera: Nymphalidae), and an unidentified stem-boring moth (Lepidoptera: Tortricidae): the latter was tested in quarantine but rejected because it attacked several sunflower cultivars. Only one pathogen, Puccinia enceliae Dietel & Holw. (Uredinales: Pucciniaceae), was found that could potentially have been used as a biological control agent against the Tithonia species, but attempts to culture this rust were unsuccessful."

Summary of Risk Traits:

High Risk / Undesirable Traits
• Elevation range exceeds 1000 m, demonstrating environmental versatility
• Thrives in tropical climates
• Naturalized on Kauai, Oahu, Maui & Hawaii (Hawaiian Islands) & widely naturalize elsewhere
• Disturbance & crop weed; potential environmental weed
• Other Tithonia species are invasive
• Allelopathic
• Tolerates many soil types
• Forms dense stands
• Reproduces by seeds & vegetatively by suckers, fragments & coppices
• Able to reach maturity in <1 year in certain environments
• Seeds & fragments dispersed by wind, water, animals, people & as a contaminant
• Prolific seed production
• Able to coppice & resprout after cutting

Low Risk Traits
• Unarmed (no spines, thorns, or burrs)
• Provides fodder for livestock (palatable despite reports of toxicity)
• Ornamental
• Thrives in full sun (may limit spread into shaded habitats)
• Herbicides may provide effective control