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| Taxon: <i>Tithonia rotundifolia</i> (Mill.) S. F. Blake | Family: Asteraceae |
| Common Name(s): Mexican sunflower red sunflower | Synonym(s): <i>Helianthus speciosus</i> Hook. <i>Tagetes rotundifolia</i> Mill. <i>Tithonia speciosa</i> (Hook.) Griseb. |

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|--------------------------------|----------------------------------|------------------------------|
| Assessor: Chuck Chimera | Status: Assessor Approved | End Date: 26 Jul 2017 |
| WRA Score: 15.0 | Designation: H(HPWRA) | Rating: High Risk |

Keywords: Naturalized Herb, Crop Weed, Annual, Self-Incompatible, Prolific Seeder

| Qsn # | Question | Answer Option | Answer |
|-------|---|--|--------|
| 101 | Is the species highly domesticated? | y=-3, n=0 | n |
| 102 | Has the species become naturalized where grown? | | |
| 103 | Does the species have weedy races? | | |
| 201 | Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical" | (0-low; 1-intermediate; 2-high) (See Appendix 2) | High |
| 202 | Quality of climate match data | (0-low; 1-intermediate; 2-high) (See Appendix 2) | High |
| 203 | Broad climate suitability (environmental versatility) | y=1, n=0 | y |
| 204 | Native or naturalized in regions with tropical or subtropical climates | y=1, n=0 | y |
| 205 | Does the species have a history of repeated introductions outside its natural range? | y=-2, ?=-1, n=0 | y |
| 301 | Naturalized beyond native range | y = 1*multiplier (see Appendix 2), n= question 205 | y |
| 302 | Garden/amenity/disturbance weed | 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 | | |
| 403 | Parasitic | y=1, n=0 | n |
| 404 | Unpalatable to grazing animals | | |
| 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 |
| 408 | Creates a fire hazard in natural ecosystems | | |
| 409 | Is a shade tolerant plant at some stage of its life cycle | | |

| Qsn # | Question | Answer Option | Answer |
|-------|--|---|--------|
| 410 | Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island) | y=1, n=0 | y |
| 411 | Climbing or smothering growth habit | y=1, n=0 | n |
| 412 | Forms dense thickets | y=1, n=0 | y |
| 501 | Aquatic | y=5, n=0 | n |
| 502 | Grass | y=1, n=0 | n |
| 503 | Nitrogen fixing woody plant | y=1, n=0 | n |
| 504 | Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers) | y=1, n=0 | n |
| 601 | Evidence of substantial reproductive failure in native habitat | y=1, n=0 | n |
| 602 | Produces viable seed | y=1, n=-1 | y |
| 603 | Hybridizes naturally | y=1, n=-1 | y |
| 604 | Self-compatible or apomictic | y=1, n=-1 | n |
| 605 | Requires specialist pollinators | y=-1, n=0 | n |
| 606 | Reproduction by vegetative fragmentation | y=1, n=-1 | n |
| 607 | Minimum generative time (years) | 1 year = 1, 2 or 3 years = 0, 4+ years = -1 | 1 |
| 701 | Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas) | y=1, n=-1 | y |
| 702 | Propagules dispersed intentionally by people | y=1, n=-1 | y |
| 703 | Propagules likely to disperse as a produce contaminant | y=1, n=-1 | y |
| 704 | Propagules adapted to wind dispersal | y=1, n=-1 | n |
| 705 | Propagules water dispersed | y=1, n=-1 | y |
| 706 | Propagules bird dispersed | y=1, n=-1 | n |
| 707 | Propagules dispersed by other animals (externally) | y=1, n=-1 | y |
| 708 | Propagules survive passage through the gut | y=1, n=-1 | n |
| 801 | Prolific seed production (>1000/m2) | y=1, n=-1 | y |
| 802 | Evidence that a persistent propagule bank is formed (>1 yr) | y=1, n=-1 | n |
| 803 | Well controlled by herbicides | y=-1, n=1 | y |
| 804 | Tolerates, or benefits from, mutilation, cultivation, or fire | y=1, n=-1 | n |
| 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 |
| | Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321 | [No evidence] "It is a native of Central America and the Antilles and has the widest native range of any member of the genus." |

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|-----|---|-------|
| 102 | Has the species become naturalized where grown? | |
| | Source(s) | Notes |
| | WRA Specialist. 2017. Personal Communication | NA |

| | | |
|-----|--|-------|
| 103 | Does the species have weedy races? | |
| | Source(s) | Notes |
| | WRA Specialist. 2017. 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. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 24 Jul 2017] | "Native: Northern America Northern Mexico: Mexico - Coahuila, - Durango, - Zacatecas Southern Mexico: Mexico - Campeche, - Chiapas, - Colima, - Guerrero, - Hidalgo, - Jalisco, - Mexico, - Morelos, - Nayarit, - Oaxaca, - Quintana Roo, - Veracruz, - Yucatan Southern America Central America: Belize; Costa Rica; El Salvador; Guatemala; Honduras; Nicaragua; Panama" |

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|-----|---|-------|
| 202 | Quality of climate match data | High |
| | Source(s) | Notes |
| | USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 24 Jul 2017] | |

| Qsn # | Question | Answer |
|-------|---|--|
| 203 | Broad climate suitability (environmental versatility) | y |
| | Source(s) | Notes |
| | Hyde, M.A., Wursten, B.T., Ballings, P. & Coates Palgrave, M. (2017). Flora of Zimbabwe: Species information: <i>Tithonia rotundifolia</i> . http://www.zimbabweflora.co.zw/ . [Accessed 25 Jul 2017] | "Altitude range: (metres) 400 - 1580 m" [Elevation range exceeds 1000 m] |
| | Tropicos.org. 2017. Tropicos [Online Database]. Missouri Botanical Garden. http://www.tropicos.org/ . [Accessed 25 Jul 2017] | Collected from 0 m - 1990 m elevation. Collected from 31°22'00"S to 03°21'51"S latitude and 04°02'00"N to >22°06'00"N latitude. [Broad distribution and elevation range] |

| 204 | Native or naturalized in regions with tropical or subtropical climates | y |
|-----|---|--|
| | Source(s) | Notes |
| | USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 24 Jul 2017] | "Native: Northern America Northern Mexico: Mexico - Coahuila, - Durango, - Zacatecas Southern Mexico: Mexico - Campeche, - Chiapas, - Colima, - Guerrero, - Hidalgo, - Jalisco, - Mexico, - Morelos, - Nayarit, - Oaxaca, - Quintana Roo, - Veracruz, - Yucatan Southern America Central America: Belize; Costa Rica; El Salvador; Guatemala; Honduras; Nicaragua; Panama Naturalized: Africa South Tropical Africa: Zambia; Zimbabwe Southern Africa: Botswana; South Africa; Swaziland West Tropical Africa: Senegal West-Central Tropical Africa: Rwanda; Zaire Australasia Australia: Australia - New South Wales, - Queensland Northern America Southeastern U.S.A.: United States - Florida, - Louisiana" |

| 205 | Does the species have a history of repeated introductions outside its natural range? | y |
|-----|---|--------------|
| | Source(s) | Notes |
| | | |

| Qsn # | Question | Answer |
|-------|---|--|
| | <p>USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 24 Jul 2017]</p> | <p>"Naturalized: Africa South Tropical Africa: Zambia; Zimbabwe Southern Africa: Botswana; South Africa; Swaziland West Tropical Africa: Senegal West-Central Tropical Africa: Rwanda; Zaire Australasia Australia: Australia - New South Wales, - Queensland Northern America Southeastern U.S.A.: United States - Florida, - Louisiana Southern America Brazil: Brazil Caribbean: Cuba; Guadeloupe; Hispaniola; Martinique; Netherlands Antilles - Saba; Puerto Rico; St. Lucia; Trinidad and Tobago - Trinidad Northern South America: Venezuela Southern South America: Argentina"</p> |

| 301 | Naturalized beyond native range | y |
|-----|---|--|
| | Source(s) | Notes |
| | <p>USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html. [Accessed 24 Jul 2017]</p> | <p>"Naturalized: Africa South Tropical Africa: Zambia; Zimbabwe Southern Africa: Botswana; South Africa; Swaziland West Tropical Africa: Senegal West-Central Tropical Africa: Rwanda; Zaire Australasia Australia: Australia - New South Wales, - Queensland Northern America Southeastern U.S.A.: United States - Florida, - Louisiana Southern America Brazil: Brazil Caribbean: Cuba; Guadeloupe; Hispaniola; Martinique; Netherlands Antilles - Saba; Puerto Rico; St. Lucia; Trinidad and Tobago - Trinidad Northern South America: Venezuela Southern South America: Argentina"</p> |
| | <p>Liogier, A.H. & Martorell, L.F. 2000. Flora of Puerto Rico and adjacent islands: a systematic synopsis. Second Edition Revised. La Editorial, UPR, San Juan, Puerto Rico</p> | <p>"On roadsides, banks and pastures at lower elevations, escaped from gardens, Puerto Rico; a native to Mexico and Central America, widely cultivated and naturalized in tropical America."</p> |

| Qsn # | Question | Answer |
|-------|---|---|
| | Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of <i>Tithonia diversifolia</i> (Hemsl.) Gray and <i>Tithonia rotundifolia</i> (PM) Blake. <i>Applied Ecology and Environmental Research</i> , 3(1), 39-46 | "Recently two species, <i>Tithonia diversifolia</i> and <i>Tithonia rotundifolia</i> , of the 11 species of the genus <i>Tithonia</i> , 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 <i>Tithonia diversifolia</i> 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. They are allopatric, never found growing in mixed population. Opinions vary as regards their introduction and subsequent establishment. In West Africa, <i>Tithonia diversifolia</i> has been reported to be introduced as an ornamental plant [1] and with imported grains [11]." |
| | Parker, J.L. & Parsons, B. 2016. New Plant Records from the Big Island for 2015. <i>Bishop Museum Occasional Papers</i> 118: 17–22 | " <i>Tithonia rotundifolia</i> (mill.) S.F. Blake New naturalized record This Mexican sunflower is related to the more common <i>T. diversifolia</i> but differs in that it is a smaller species, up to 12 ft tall, with scarlet to orange-red ray flowers. Leaves are either entire or 3–5-lobed with coarsely toothed or serrate leaf margins and cordate leaf bases. Also, it has finely hairy involucre bracts in 2 or 3 whorls (Staples & Herbst 2005). This species is difficult to identify in its vegetative form due to its superficial similarity to the very common <i>Hyptis pectinate</i> . Material examined. HAWAII: North Kona Distr., Donkey mill road, Hōlualoa, 2167127N 191318e, vigorous, bushy, multi-branched shrub about 8–10 ft tall, 6 Oct 2014, J. Parker & R. Parsons BIED180." |

| 302 | Garden/amenity/disturbance weed | y |
|-----|---|---|
| | Source(s) | Notes |
| | Hyde, M.A., Wursten, B.T., Ballings, P. & Coates Palgrave, M. (2017). <i>Flora of Zimbabwe: Species information: Tithonia rotundifolia</i> . http://www.zimbabweflora.co.zw/ . [Accessed 25 Jul 2017] | "A weed of roadsides and disturbed ground, often forming large colonies of tall, stout plants in damp, shady places." |
| | Invasive Species South Africa. 2017. Red sunflower - <i>Tithonia rotundifolia</i> . http://www.invasives.org.za/ . [Accessed 26 Jul 2017] | "Why is it a problem? It competes with indigenous species and obstructs access to riverbanks. Dense stands along road verges can obstruct motorists' vision." |

| 303 | Agricultural/forestry/horticultural weed | y |
|-----|---|---|
| | Source(s) | Notes |
| | Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of <i>Tithonia diversifolia</i> (Hemsl.) Gray and <i>Tithonia rotundifolia</i> (PM) Blake. <i>Applied Ecology and Environmental Research</i> , 3(1), 39-46 | " <i>Tithonia diversifolia</i> and <i>Tithonia rotundifolia</i> whose reproductive strategies and seed germination were investigated in this study are invasive plants introduced to Africa by humans which have become established and spread into natural ecosystems. They have also become serious weeds of arable crops and plantations in Africa." |
| | Randall, R.P. (2017). <i>A Global Compendium of Weeds</i> . 3rd Edition. Perth, Western Australia. R.P. Randall | "Weed of: Cereals, Orchards & Plantations, Sunflowers" |

| 304 | Environmental weed | |
|-----|--------------------|--|
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| Qsn # | Question | Answer |
|-------|--|--|
| | Source(s) | Notes |
| | Simelane, D. O., Mawela, K. V., & Fourie, A. (2011). Prospective agents for the biological control of <i>Tithonia rotundifolia</i> (Mill.) SF Blake and <i>Tithonia diversifolia</i> (Hemsl.) A. Gray (Asteraceae) in South Africa. <i>African Entomology</i> , 19(2), 443-450 | [Potentially] "The increasing abundance of <i>T. rotundifolia</i> and <i>T. diversifolia</i> 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." |

| 305 | Congeneric weed | y |
|-----|---|--|
| | Source(s) | Notes |
| | CABI, 2017. <i>Invasive Species Compendium</i> . Wallingford, UK: CAB International. www.cabi.org/isc | " <i>T. diversifolia</i> , commonly known as the tree marigold, is a herbaceous flowering plant in the Asteraceae family. Native to Mexico, Central America and Cuba, it has been introduced and 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. <i>T. diversifolia</i> tolerates heat and drought and can rapidly form large herbaceous shrubs. Rapid vegetative reproduction and significant production of lightweight seeds, which can be dormant in the soil for up to four months, allow <i>T. diversifolia</i> to quickly invade disturbed habitats. By forming dense stands it prevents the growth of young native plants. Depending on the area, <i>T. diversifolia</i> may be either annual or perennial. Being able to produce flowers and seeds throughout the year, coupled with the ability of seeds to be dispersed by wind, water and animals, makes it particularly easy for <i>T. diversifolia</i> to quickly colonize new areas. Shoot and root growth and nutrient uptake of several plants may be adversely affected by <i>T. diversifolia</i> ." ... "Areas highly infested by <i>T. diversifolia</i> experience a reduction in biodiversity since grass species growing beneath it are destroyed due to the allelopathic effect of the plant." |

| 401 | Produces spines, thorns or burrs | n |
|-----|--|---|
| | Source(s) | Notes |
| | Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al. 1975. <i>Flora of Panama</i> . Part IX. Family 184. Compositae. <i>Annals of the Missouri Botanical Garden</i> 62(4): 835-1321 | [No evidence] "Large, shrublike, short-lived herb to 4 m tall; stems drying green or brown, striate, puberulent. Leaves to 35 cm long, ovate or cuneiform, sometimes broadly so, apically and basally acuminate, entire or 3-5-lobed, the lobes ovate with obtuse sinuses, the margins mostly crenate, scabridulous above with short stout hairs and occasional glands, softly pubescent beneath with stout, arching, verrucose hairs; petiole elongate, winged in the upper portion, basally clasping the stem." |

| 402 | Allelopathic | |
|-----|------------------|--------------|
| | Source(s) | Notes |

| Qsn # | Question | Answer |
|-------|---|---|
| | <p>Otusanya, O., & Ilori, O. (2013). Studies on the allelopathic effects of <i>Tithonia rotundifolia</i> on the germination and seedling growth of some legumes and cereals. <i>International Journal of Biology</i>, 6(1), 38-47</p> | <p>"The study investigated the allelopathic effects of <i>Tithonia rotundifolia</i> on the germination and growth of two legumes (<i>Vigna unguiculata</i> and <i>Glycine max</i>) and two cereals (<i>Zea mays</i> and <i>Sorghum bicolor</i>). This was with a view to determining the susceptibility of these test crops to allelochemicals. The germination studies were carried out by raising seedlings in Petri-dishes which had been lined with Whatman No. 1 filter paper. Ten millilitres of 100%, 75%, 50% and 25% concentrations of the methanolic or water extract solutions were used for the treatments while distilled water served as control. Germination and growth analyses were carried out according to standard methods. The data obtained were analysed by Factorial Analysis of Variance (ANOVA) to determine significant ($P < 0.05$) effects. The germination and growth of the juvenile seedlings of all the test crops were significantly inhibited by the methanolic and water extracts dose dependently. However, the methanolic extracts had a more pronounced inhibitory effect on these parameters. The study concluded that the methanolic extracts were more phytotoxic and had higher inhibitory effects on the parameters than the water extracts. Also, it was observed that the response of plants to allelochemical toxicity was dependent on plant species." ... "It can be summarized from the results of this study that both the water and methanolic extracts at any concentration inhibited the germination, growth and ultimately the yield of the test crops. The methanolic extract was more phytotoxic than the water extracts. The extent of the inhibition by the water and methanolic extracts followed this order: 100% > 75% > 50% > 25%. This affirmed the fact that the response of the target crops was extract concentration dependent. In conclusion, the effectiveness of these extracts on the germination and growth of the crops in this study showed that the presence of <i>T. rotundifolia</i> would negatively affect the neighboring or successional crop plants."</p> |

| 403 | Parasitic | n |
|-----|---|--|
| | Source(s) | Notes |
| | <p>Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. <i>Flora of Panama</i>. Part IX. Family 184. Compositae. <i>Annals of the Missouri Botanical Garden</i> 62(4): 835-1321</p> | <p>"Large, shrublike, short-lived herb to 4 m tall; stems drying green or brown, striate, puberulent." [Asteraceae. No evidence]</p> |

| Qsn # | Question | Answer |
|-------|--|--|
| 404 | Unpalatable to grazing animals | |
| | Source(s) | Notes |
| | Jull, L.G. 2001. Plants not favored by deer. A3727. University of Wisconsin Extension, Madison, WI | "If deer are hungry enough, they will eat almost anything. However, there are a number of woody and herbaceous plants that deer usually don't find appealing. Many of these plants are listed below, though this list is not definitive as deer preferences vary by region." [Tithonia rotundifolia (tithonia) included in list of non-favored plants] |
| | Prakash, B., Rathore, S. S., Khate, K., & Rajkhowa, C. (2013). Nutrient composition of forest based foliages consumed by Mithun (<i>Bos frontalis</i>) under Imphal district of Manipur. Livestock Research for Rural Development, 25 (10). http://lrrd.cipav.org.co/lrrd25/10/prak25187.htm . [Accessed 26 Jul 2017] | "Table 1. Local name and chemical composition* (% DM basis) of different foliages of Manipur" [Tithonia rotundifolia fed to cattle in India] |

| 405 | Toxic to animals | n |
|-----|---|--|
| | Source(s) | Notes |
| | Gardenersworld.com. 2017. Tithonia rotundifolia Mexican sunflower. http://www.gardenersworld.com/plants/plant-finder/tithonia-rotundifolia/ . [Accessed 26 Jul 2017] | "Effects: No toxic effects reported for this plant." |
| | Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL | [Medicinal. No evidence] "Tithonia rotundifolia ... Antiinflammatory, antiseptic, a treatment for wounds and skin diseases." |
| | Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL | No evidence |

| 406 | Host for recognized pests and pathogens | |
|-----|---|--|
| | Source(s) | Notes |
| | Ruter, J. M., & Gitaitis, R. D. (1993). First report of tomato spotted wilt virus on bedding plants in Georgia. Plant Disease, 77(1): 101 | "Abstract : Symptomatic bedding plants in 5 Georgia counties were sampled during Apr.-Jun. 1991. About 7% of the samples tested positive for the impatiens serotype of tomato spotted wilt tospovirus (TSWV-I) and 6% tested positive for the lettuce serotype (TSWV-L). Infected plants were detected by ELISA of whole-leaf tissue samples. Catharanthus roseus, Chrysanthemum leucanthemum [Leucanthemum vulgare], Digitalis purpurea, Eustoma grandiflorum, Gerbera jamesonii, Gomphrena globosa, Impatiens walleriana [I. walleriana], Petunia x hybrida, Phlox divaricata, P. drummondii and Plectranthus australis [P. parviflorus] tested positive for TSWV-I, Ageratum houstonianum, Gazania spp., Tithonia rotundifolia and Viola x wittrockiana tested positive for TSWV-L, and I. walleriana and Nicotiana alata tested positive for both serotypes. " |
| | Ruter, J. M., & Gitaitis, R. D. 1993. Tomato Spotted Wilt Virus on Bedding Plants in South Georgia. Georgia Commercial Flower Growers Association. July - August, 1993. Page 16 | "Nature of Work: Tomato spotted wilt virus has become a major threat to agronomic and horticultural crops in the southeastern United States. Outbreaks of tomato spotted wilt virus have occurred on green house crops and bedding plants in recent years, resulting in severe losses." ... "Table 1. Plants testing positive for the impatiens serotype (TSWV-I) and lettuce serotype (TSWV-L) of tomato spotted wilt virus in south Georgia" [Tithonia rotundifolia tests positive] |

| Qsn # | Question | Answer |
|-------|--|---|
| | Missouri Botanical Garden. 2017. <i>Tithonia rotundifolia</i> . http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=b763 . [Accessed 26 Jul 2017] | "Problems - No serious insect or disease problems. Watch for slugs and snails." |

| 407 | Causes allergies or is otherwise toxic to humans | n |
|-----|--|--|
| | Source(s) | Notes |
| | Gardenersworld.com. 2017. <i>Tithonia rotundifolia</i> Mexican sunflower. http://www.gardenersworld.com/plants/plant-finder/tithonia-rotundifolia/ . [Accessed 26 Jul 2017] | "Effects: No toxic effects reported for this plant." |
| | Quattrocchi, U. 2012. CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL | [Medicinal. No evidence] " <i>Tithonia rotundifolia</i> ... Antiinflammatory, antiseptic, a treatment for wounds and skin diseases." |

| 408 | Creates a fire hazard in natural ecosystems | |
|-----|---|--|
| | Source(s) | Notes |
| | Tovar-Sánchez, E., Rodríguez-Carmona, F., Aguilar-Mendiola, V., Mussali-Galante, P., López-Caamal, A., & Valencia-Cuevas, L. (2012). Molecular evidence of hybridization in two native invasive species: <i>Tithonia tubaeformis</i> and <i>T. rotundifolia</i> (Asteraceae) in Mexico. <i>Plant Systematics and Evolution</i> , 298(10), 1947-1959 | " <i>T. rotundifolia</i> inhabits arid zones below 1,000 m a.s.l." [May occur in fire prone habitats] |
| | Invasive Species South Africa. 2017. Red sunflower - <i>Tithonia rotundifolia</i> . http://www.invasives.org.za/ . [Accessed 26 Jul 2017] | [May increase fuel load] "Why is it a problem? It competes with indigenous species and obstructs access to riverbanks. Dense stands along road verges can obstruct motorists' vision." |
| | WRA Specialist. 2017. Personal Communication | Unknown. Fire ecology not studied. May add to fuel load and increase fire risk, but direct evidence lacking |

| 409 | Is a shade tolerant plant at some stage of its life cycle | |
|-----|---|--|
| | Source(s) | Notes |
| | Ellis, B.W. 1999, <i>Taylor's Guide to Annuals: How to Select and Grow More Than 400 Annuals, Biennials, and Tender Perennials</i> . Houghton Mifflin Harcourt, New York, NY | "Full sun" |
| | Gardenersworld.com. 2017. <i>Tithonia rotundifolia</i> Mexican sunflower. http://www.gardenersworld.com/plants/plant-finder/tithonia-rotundifolia/ . [Accessed 26 Jul 2017] | "Sun exposure: Full sun" |
| | Reyes-Valdés, M. H., Villarreal-Quintanilla, J. A., Santana-Michel, F. J., & Salmerón, E. (2007). Distribution and collection of <i>Tithonia rotundifolia</i> in south-east Mexico. <i>Proceedings of the Interamerican Society for Tropical Horticulture</i> 51: 289-293 | [Half-shade] "It was observed that several populations develop under full solar exposition, whereas others grow in half-shade within the forest area." |

| 410 | Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island) | y |
|-----|--|---|
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| Qsn # | Question | Answer |
|-------|--|---|
| | Source(s) | Notes |
| | Snyder, L.C. 1983. Flowers for Northern Gardens. University of Minnesota Press, Minneapolis, MN | "Plants like a moist, well-drained soil and full sun." |
| | Ellis, B.W. 1999, Taylor's Guide to Annuals: How to Select and Grow More Than 400 Annuals, Biennials, and Tender Perennials. Houghton Mifflin Harcourt, New York, NY | "Poor to average, well-drained soil" |
| | The Royal Horticultural Society. 2017. <i>Tithonia rotundifolia</i> - Mexican sunflower. https://www.rhs.org.uk/Plants/74374/Tithonia-rotundifolia/Details . [Accessed 26 Jul 2017] | "Soil - Loam, Sand pH - Neutral, Acid, Alkaline" |
| | Missouri Botanical Garden. 2017. <i>Tithonia rotundifolia</i> . http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=b763 . [Accessed 26 Jul 2017] | "Warm weather annual that is easily grown in average, dry to medium, well-drained soils in full sun. Plants thrive in summer heat. Plants tolerate poor soils. Avoid rich soils which tend to produce weak-stemmed plants with excess foliage." |

| 411 | Climbing or smothering growth habit | n |
|-----|--|---|
| | Source(s) | Notes |
| | Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321 | "Large, shrublike, short-lived herb to 4 m tall; stems drying green or brown, striate, puberulent." |

| 412 | Forms dense thickets | y |
|-----|---|---|
| | Source(s) | Notes |
| | Hyde, M.A., Wursten, B.T., Ballings, P. & Coates Palgrave, M. (2017). Flora of Zimbabwe: Species information: <i>Tithonia rotundifolia</i> . http://www.zimbabweflora.co.zw/ . [Accessed 25 Jul 2017] | "A weed of roadsides and disturbed ground, often forming large colonies of tall, stout plants in damp, shady places." |
| | Invasive Species South Africa. 2017. Red sunflower - <i>Tithonia rotundifolia</i> . http://www.invasives.org.za/ . [Accessed 26 Jul 2017] | "Why is it a problem? It competes with indigenous species and obstructs access to riverbanks. Dense stands along road verges can obstruct motorists' vision." |

| 501 | Aquatic | n |
|-----|--|--|
| | Source(s) | Notes |
| | Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321 | [Terrestrial] "Large, shrublike, short-lived herb to 4 m tall" |
| | Parker, J.L. & Parsons, B. 2016. New Plant Records from the Big Island for 2015. Bishop Museum Occasional Papers 118: 17–22 | [Terrestrial] "Material examined. HAWAÍ: North kona Distr., Donkey mill road, Hōlualoa, 2167127N 191318e, vigorous, bushy, multi-branched shrub about 8–10 ft tall, 6 oct 2014, J. Parker & R. Parsons BIED180." |

| Qsn # | Question | Answer |
|-------|---|---------------------------------------|
| 502 | Grass | n |
| | Source(s) | Notes |
| | USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 24 Jul 2017] | "Family: Asteraceae (alt.Compositae)" |

| | | |
|-----|---|---------------------------------------|
| 503 | Nitrogen fixing woody plant | n |
| | Source(s) | Notes |
| | USDA, ARS, Germplasm Resources Information Network. 2017. National Plant Germplasm System [Online Database]. http://www.ars-grin.gov/npgs/index.html . [Accessed 24 Jul 2017] | "Family: Asteraceae (alt.Compositae)" |

| | | |
|-----|--|--|
| 504 | Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers) | n |
| | Source(s) | Notes |
| | Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321 | "Large, shrublike, short-lived herb to 4 m tall; stems drying green or brown, striate, puberulent" |

| | | |
|-----|--|--|
| 601 | Evidence of substantial reproductive failure in native habitat | n |
| | Source(s) | Notes |
| | Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321 | [No evidence] "It is a native of Central America and the Antilles and has the widest native range of any member of the genus." |

| | | |
|-----|----------------------|-------|
| 602 | Produces viable seed | y |
| | Source(s) | Notes |

| Qsn # | Question | Answer |
|-------|---|--|
| | Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of <i>Tithonia diversifolia</i> (Hemsl.) Gray and <i>Tithonia rotundifolia</i> (PM) Blake. <i>Applied Ecology and Environmental Research</i> , 3(1), 39-46 | "Abstract. Seed germination and reproductive strategies of <i>Tithonia diversifolia</i> and <i>Tithonia rotundifolia</i> , two invasive species introduced into Africa from North and Central America, were studied. The aim was to determine the characteristics that make them invasive species in the continent. <i>Tithonia diversifolia</i> is a perennial and polycarpic plant reproducing both sexually and asexually while <i>Tithonia rotundifolia</i> is an annual monocarpic plant reproducing only sexually. The seeds of these species exhibit a period of dormancy before germinating. <i>Tithonia diversifolia</i> produces small sized light and numerous seeds while <i>Tithonia rotundifolia</i> produces larger sized, heavier and fewer seeds. <i>Tithonia rotundifolia</i> allocates a high proportion of of dry matter (41.6 %) and <i>Tithonia diversifolia</i> low proportion (10.5 %) to reproduction. It is concluded that small sized light and numerous seeds produced by <i>Tithonia diversifolia</i> 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. While the larger heavier seeds and high reproductive effort of <i>Tithonia rotundifolia</i> ensures its early vigorous start in seedling growth, quick establishment, survival for longer and to grow to more aggressive size in an environment that is starved of resources. Seed dormancy exhibited by the two species ensures they survive adverse conditions in their environment as seeds and germinate only when the environmental conditions favour the survival of their seedlings." |
| | Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. <i>Flora of Panama</i> . Part IX. Family 184. Compositae. <i>Annals of the Missouri Botanical Garden</i> 62(4): 835-1321 | "Achene body 5-6 mm long, flat, the endocarp blackish, appearing gray under the weak, white, ascending indumentum; carpodium inconspicuous; pappus of two sturdy, persistent 3-5 mm long awns and a ring of broad, distinct, 2-3 mm long scales." |
| | Snyder, L.C. 1983. <i>Flowers for Northern Gardens</i> . University of Minnesota Press, Minneapolis, MN | "Propagation is by seeds started indoors in early April." |

| 603 | Hybridizes naturally | y |
|-----|---|---|
| | Source(s) | Notes |
| | Tovar-Sánchez, E., Rodríguez-Carmona, F., Aguilar-Mendiola, V., Mussali-Galante, P., López-Caamal, A., & Valencia-Cuevas, L. (2012). Molecular evidence of hybridization in two native invasive species: <i>Tithonia tubaeformis</i> and <i>T. rotundifolia</i> (Asteraceae) in Mexico. <i>Plant Systematics and Evolution</i> , 298(10), 1947-1959 | " <i>Tithonia tubaeformis</i> and <i>T. rotundifolia</i> are sunflower species that have broad areas of sympatry in Mexico where they hybridize in the wild. Our results suggest that <i>T. tubaeformis</i> and <i>T. rotundifolia</i> in hybrid zones do not represent fully isolated gene pools. Despite natural hybridization, <i>T. tubaeformis</i> and <i>T. rotundifolia</i> remain morphologically, genetically, and ecologically distinct." |

| 604 | Self-compatible or apomictic | n |
|-----|------------------------------|-------|
| | Source(s) | Notes |
| | | |

| Qsn # | Question | Answer |
|-------|---|--|
| | Noyes, R. D. 2007. Apomixis in the Asteraceae: diamonds in the rough. <i>Functional Plant Science and Biotechnology</i> , 1(2): 207-222 | "Pullaiah (1984) notes that apospory in <i>Tithonia</i> is "observed in some cases" but that no 'further development of the aposporic embryo sac is noticed', indicating that effective apomixis is not indicated" ... "1978). However, Pullaiah (1984) notes that gametophytes of aposporous origin fail to produce embryos. Chromosome numbers for <i>Tithonia</i> (FNA 2006, 21: 139) are uniformly diploid indicating that aposporous female gametophyte formation in this genus is likely inconsequential." |
| | Tovar-Sánchez, E., Rodríguez-Carmona, F., Aguilar-Mendiola, V., Mussali-Galante, P., López-Caamal, A., & Valencia-Cuevas, L. (2012). Molecular evidence of hybridization in two native invasive species: <i>Tithonia tubaeformis</i> and <i>T. rotundifolia</i> (Asteraceae) in Mexico. <i>Plant Systematics and Evolution</i> , 298(10), 1947-1959 | [Hybrids may be partially self-compatible] " <i>Tithonia tubaeformis</i> and <i>T. rotundifolia</i> are two annual diploid species (n = 17) native to Mexico and Central America (LaDuke 1982) that occupy disturbed habitats such as roadsides and croplands. These species show sporophytic incompatibility, and thus are obligate outcrossers (Muoghalu and Chuba 2005)." ... "In Asteraceae family, self-incompatibility is considered an ancestral character. For example, Holsinger (2000) suggests that hermaphrodite and self-incompatible flowers, such as <i>T. rotundifolia</i> and <i>T. tubaeformis</i> do not have any (or have a very low) possibility of self-fertilization. In this context, cross-pollination may be favored as well as crossing with individuals of different taxa. However, a partial breakdown of self-incompatibility has been documented in the Asteraceae family, particularly in annual and herbaceous species, including <i>T. tubaeformis</i> and <i>T. rotundifolia</i> (Ferrer et al. 2004). Additionally, it has been proposed that under xeric conditions, selection may favor a partial breakdown of self-incompatibility due to the low availability of pollinators in these types of environments (Ferrer et al. 2004). Under this scenario, if we consider that hybrid individuals of <i>T. tubaeformis</i> and <i>T. rotundifolia</i> are under xeric conditions, then they can present partial self-compatibility, which may increase seed numbers in circumstances where pollen exchange is limited. In this case, although hybrid individuals are less fertile (about 26 %; LaDuke 1982), they can establish and produce sufficient seed to maintain hybrid zones." |

| 605 | Requires specialist pollinators | n |
|-----|---|---|
| | Source(s) | Notes |
| | Frey, K. & LeBuhn, G. 2016. <i>The Bee-Friendly Garden: Design an Abundant, Flower-Filled Yard that Nurtures Bees and Supports Biodiversity</i> . Ten Speed Press, NY | "A favorite and easy summer combination of large, summer annuals is purple spider flower (<i>Cleome</i>), Mexican sunflowers (<i>Tithonia rotundifolia</i>), and orange Klondike cosmos (<i>Cosmos sulphureus</i>) for a soft purple and bright orange explosion." ... "Many bee species visit the Mexican sunflower as well as butterflies." |

| Qsn # | Question | Answer |
|-------|---|--|
| | Woodson, Jr., R.E., Schery, R.W., D'Arcy, W.G. et al.1975. Flora of Panama. Part IX. Family 184. Compositae. Annals of the Missouri Botanical Garden 62(4): 835-1321 | "Inflorescence of solitary or clustered terminal flowers on elongate apically expanded, striate, puberulent peduncles 8-20 cm long with one or more large or small foliaceous bracts along their length. Heads large and showy, radiate; involucre bracts 20-30 mm across, in several subequal series, 10-15 mm long, indurated, many nerved, whitish puberulent, the outermost slightly longer, acute, the innermost obtuse or short acuminate; paleas hyaline, dorsally puberulent, completely enclosing the achene; ray florets several in one series, the ligules yellow or orange, 2-3 cm long, minutely 1-2-notched, puberulent outside, drying with conspicuous veins, staminode sometimes present, the ovary abortive, ca. 3 mm long, flat but faintly 3-angled, glabrous, the pappus of scalelike awns and a ring of short hairs; disc florets numerous, ca. 10 mm long, the corolla tubular, pubescent on the veins outside, the lobes yellow, cuculate with the thickened margins, dorsally papillose-pubescent, the anthers black, 4 mm long, the appendages yellow, expanded and slightly enfolded, the basal auricles connate, the filaments flattened, minutely puberulent, the ovary fertile, the style branches flattened, ventrally puberulent with a tuft of hairs at the base of the short, narrow appendage, the style base slightly expanded, the nectary stipitate, crateriform with irregular margins, enclosing the base of the style." |
| | Bauer, N. 2012. The California Wildlife Habitat Garden: How to Attract Bees, Butterflies, Birds, and Other Animals. University of California Press, Berkeley and Los Angeles, CA | "Mexican sunflower (<i>Tithonia rotundifolia</i>). Annual with vigorous growth in sun and heat, vivid orange single flowers measure 3 inches across, blooms summer/fall, 4-6 feet high, very attractive to butterflies, seeds for finches, grosbeaks, and others." |
| | Wróblewska, A., Stawiarz, E., & Masierowska, M. (2016). Evaluation of Selected Ornamental Asteraceae as a Pollen Source for Urban Bees. Journal of Apicultural Science, 60 (2), 179-192 | "They can be categorised as oblatespherical, spherical, and prolatespherical. The principal visitors to <i>C. macrocephala</i> , <i>C. sulphureus</i> , and <i>C. officinalis</i> were honey bees, whereas bumble bees dominated on <i>T. rotundifolia</i> and <i>D. pinnata</i> . A magnet plant for butterflies was <i>Z. elegans</i> . Among the investigated species, <i>D. pinnata</i> , <i>C. macrocephala</i> , and <i>T. rotundifolia</i> were found to be the most valuable sources of pollen flow for managed and wild bees." |

| 606 | Reproduction by vegetative fragmentation | n |
|-----|--|--|
| | Source(s) | Notes |
| | BioNET-EAFRINE. 2011. <i>Tithonia rotundifolia</i> (Red Sunflower). http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Tithonia_rotundifolia_(Red_Sunflower).htm . [Accessed 26 Jul 2017] | "This species invades savanna grasslands, roadsides, degraded land and riparian zones (banks of watercourses)." ... "This species reproduces by seed. It can also propagate vegetatively from basal stems. The seeds may be dispersed by animals, water and in clothing, They may also be spread in dumped garden waste and contaminated agricultural produce. Seeds can be dormant for up to four months." [Peer-reviewed studies indicate that <i>T. rotundifolia</i> does not spread vegetatively, but <i>T. diversifolia</i> does] |
| | Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of <i>Tithonia diversifolia</i> (Hemsl.) Gray and <i>Tithonia rotundifolia</i> (PM) Blake. Applied Ecology and Environmental Research, 3(1), 39-46 | " <i>Tithonia rotundifolia</i> reproduces from only seeds while <i>Tithonia diversifolia</i> reproduces from seeds and vegetative regrowth of basal stem when the plant is slashed." |

| | | |
|-----|---------------------------------|---|
| 607 | Minimum generative time (years) | 1 |
|-----|---------------------------------|---|

| Qsn # | Question | Answer |
|-------|---|---|
| | Source(s) | Notes |
| | Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of <i>Tithonia diversifolia</i> (Hemsl.) Gray and <i>Tithonia rotundifolia</i> (PM) Blake. <i>Applied Ecology and Environmental Research</i> , 3(1), 39-46 | "This high reproductive allocation and fast growth ensures that <i>T. rotundifolia</i> invades new sites and utilizes available resources in such habitats. In an on going experiment, <i>T. rotundifolia</i> seeds planted on 10 December 2004 flowered on 14 February 2005; two months and one week after planting while <i>T. diversifolia</i> planted at the same time are still young plants." |
| | Parker, J.L. & Parsons, B. 2016. New Plant Records from the Big Island for 2015. <i>Bishop Museum Occasional Papers</i> 118: 17–22 | " <i>Tithonia rotundifolia</i> is an annual monocarpic plant reproducing only sexually." |
| | Ellis, B.W. 1999, <i>Taylor's Guide to Annuals: How to Select and Grow More Than 400 Annuals, Biennials, and Tender Perennials</i> . Houghton Mifflin Harcourt, New York, NY | "Warm-weather annual" |

| 701 | Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas) | y |
|-----|--|---|
| | Source(s) | Notes |
| | Hyde, M.A., Wursten, B.T., Ballings, P. & Coates Palgrave, M. (2017). <i>Flora of Zimbabwe: Species information: Tithonia rotundifolia</i> . http://www.zimbabweflora.co.zw/ . [Accessed 25 Jul 2017] | "A weed of roadsides and disturbed ground, often forming large colonies of tall, stout plants in damp, shady places." |
| | Liogier, A.H. & Martorell, L.F. 2000. <i>Flora of Puerto Rico and adjacent islands: a systematic synopsis</i> . Second Edition Revised. La Editorial, UPR, San Juan, Puerto Rico | "On roadsides, banks and pastures at lower elevations, escaped from gardens, Puerto Rico" [Distribution along roads suggests possible movement by vehicles or machinery] |
| | BioNET-EAFRINE. 2011. <i>Tithonia rotundifolia</i> (Red Sunflower). http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Tithonia_rotundifolia_(Red_Sunflower).htm . [Accessed 25 Jul 2017] | "This species invades savanna grasslands, roadsides, degraded land and riparian zones (banks of watercourses)." ... "This species reproduces by seed. It can also propagate vegetatively from basal stems. The seeds may be dispersed by animals, water and in clothing, They may also be spread in dumped garden waste and contaminated agricultural produce. Seeds can be dormant for up to four months." |

| 702 | Propagules dispersed intentionally by people | y |
|-----|---|--|
| | Source(s) | Notes |
| | Staples, G.W. & Herbst, D.R. 2005. <i>A Tropical Garden Flora - Plants Cultivated in the Hawaiian Islands and Other Tropical Places</i> . Bishop Museum Press, Honolulu, HI | "Two species of the genus <i>Tithonia</i> A. L. Jussieu, native to Mexico and Central America, are grown here as ornamentals." |
| | Van Dijk, H. 1998. <i>Encyclopedia of Border Plants</i> . Rebo Productions, The Netherlands | [Cultivated as an ornamental] " <i>Tithonia rotundifolia</i> is a tall, sturdy plant, 1.5m (5ft) with large orange flowers resembling zinnias or small sunflowers. They flower from August into October and usually need sticks or neighbouring plants for support." |

| Qsn # | Question | Answer |
|-------|--|---|
| 703 | Propagules likely to disperse as a produce contaminant | y |
| | Source(s) | Notes |
| | Invasive Species South Africa. 2017. Red sunflower - <i>Tithonia rotundifolia</i> . http://www.invasives.org.za/ . [Accessed 26 Jul 2017] | "How does it spread? The seeds are dispersed by animals, water and on clothing, They may also be spread in dumped garden waste and contaminated agricultural produce. " |

| 704 | Propagules adapted to wind dispersal | n |
|-----|--|---|
| | Source(s) | Notes |
| | BioNET-EAFRINE. 2011. <i>Tithonia rotundifolia</i> (Red Sunflower). http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Tithonia_rotundifolia_(Red_Sunflower).htm . [Accessed 26 Jul 2017] | "This species reproduces by seed. It can also propagate vegetatively from basal stems. The seeds may be dispersed by animals, water and in clothing, They may also be spread in dumped garden waste and contaminated agricultural produce. Seeds can be dormant for up to four months." |

| 705 | Propagules water dispersed | y |
|-----|--|---|
| | Source(s) | Notes |
| | BioNET-EAFRINE. 2011. <i>Tithonia rotundifolia</i> (Red Sunflower). http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Tithonia_rotundifolia_(Red_Sunflower).htm . [Accessed 25 Jul 2017] | "This species reproduces by seed. It can also propagate vegetatively from basal stems. The seeds may be dispersed by animals, water and in clothing, They may also be spread in dumped garden waste and contaminated agricultural produce. Seeds can be dormant for up to four months." |

| 706 | Propagules bird dispersed | n |
|-----|--|---|
| | Source(s) | Notes |
| | BioNET-EAFRINE. 2011. <i>Tithonia rotundifolia</i> (Red Sunflower). http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Tithonia_rotundifolia_(Red_Sunflower).htm . [Accessed 25 Jul 2017] | "This species invades savanna grasslands, roadsides, degraded land and riparian zones (banks of watercourses)." ... "This species reproduces by seed. It can also propagate vegetatively from basal stems. The seeds may be dispersed by animals, water and in clothing, They may also be spread in dumped garden waste and contaminated agricultural produce. Seeds can be dormant for up to four months." |

| 707 | Propagules dispersed by other animals (externally) | y |
|-----|--|---|
| | Source(s) | Notes |
| | BioNET-EAFRINE. 2011. <i>Tithonia rotundifolia</i> (Red Sunflower). http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Tithonia_rotundifolia_(Red_Sunflower).htm . [Accessed 25 Jul 2017] | "This species invades savanna grasslands, roadsides, degraded land and riparian zones (banks of watercourses)." ... "This species reproduces by seed. It can also propagate vegetatively from basal stems. The seeds may be dispersed by animals, water and in clothing, They may also be spread in dumped garden waste and contaminated agricultural produce. Seeds can be dormant for up to four months." |

| 708 | Propagules survive passage through the gut | n |
|-----|--|-------|
| | Source(s) | Notes |

| Qsn # | Question | Answer |
|-------|--|---|
| | Gordon, D. R., Mitterdorfer, B., Pheloung, P. C., Ansari, S., Buddenhagen, C., Chimera, C., ... & Williams, P. A. 2010). Guidance for addressing the Australian Weed Risk Assessment questions. <i>Plant Protection Quarterly</i> , 25(2): 56-74 | "Answer 'no' where the taxon is unlikely to be eaten by animals or if seeds are not viable following passage through the gut." [No evidence of seed ingestion] |
| | BioNET-EAFRINE. 2011. <i>Tithonia rotundifolia</i> (Red Sunflower). http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Tithonia_rotundifolia_(Red_Sunflower).htm . [Accessed 26 Jul 2017] | "This species invades savanna grasslands, roadsides, degraded land and riparian zones (banks of watercourses)." ... "This species reproduces by seed. It can also propagate vegetatively from basal stems. The seeds may be dispersed by animals, water and in clothing, They may also be spread in dumped garden waste and contaminated agricultural produce. Seeds can be dormant for up to four months." [No evidence of internal dispersal] |

| 801 | Prolific seed production (>1000/m2) | y |
|-----|--|--|
| | Source(s) | Notes |
| | Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of <i>Tithonia diversifolia</i> (Hemsl.) Gray and <i>Tithonia rotundifolia</i> (PM) Blake. <i>Applied Ecology and Environmental Research</i> , 3(1), 39-46 | "Table 1. Summary of reproductive tissues production at peak growth of <i>Tithonia diversifolia</i> and <i>Tithonia rotundifolia</i> ." ... " <i>Tithonia rotundifolia</i> - Number of seeds per plant - 17629.33±3843.23" |
| | Isichei, A. O., & Akin-Fajiye, M. A. (2013). Plant invasions in Nigeria. Chapter 20 in: <i>Nigerian Forests: Protection and Sustainable Development</i> . Okon, E, Bown, D. and Isichei, A. (eds). JABU Environmental Symposium Series, Joseph Ayo Babalola University, Ikeji-Arakeji, Nigeria | "the prodigious amount of seeds produced by <i>Tithonia rotundifolia</i> creates larger soil seed bank relative to other species from which the next seasons growth may occur." |

| 802 | Evidence that a persistent propagule bank is formed (>1 yr) | n |
|-----|---|---|
| | Source(s) | Notes |
| | Muoghalu, J. I., & Chuba, D. K. (2005). Seed germination and reproductive strategies of <i>Tithonia diversifolia</i> (Hemsl.) Gray and <i>Tithonia rotundifolia</i> (PM) Blake. <i>Applied Ecology and Environmental Research</i> , 3(1), 39-46 | "But the seeds of <i>T. rotundifolia</i> did not germinate immediately until 4 months (30 per cent germination) after harvest from the field. The highest germination percentage was 45 per cent after 5 months. This period of initial dormancy was completed when the seeds were stored dry at room temperature. Scarification of these seeds with concentrated sulphuric acid for varying periods did not improve the germination of these seeds especially those of <i>T. rotundifolia</i> . Thus, it is concluded that that the seeds of these species exhibit either innate dormancy due to immaturity of the embryos which required some period of after ripening to reach maturity or enforced dormancy due to low temperatures prevalent in Zambia between April and August. This dormancy was broken probably by seasonal stimulus specifically thermoperiod because of higher temperatures in Zambia between September and November. Seed dormancy enables plants survive adverse environmental conditions with low levels of metabolic activity and to resume active growth when more favourable conditions return. It also allows a timing of germination in a periodically fluctuating environment. Seed dormancy observed in these species ensures that they survive adverse conditions in their environment as dormant seeds only to germinate when the environmental conditions favour the survival of their seedlings." |

| Qsn # | Question | Answer |
|-------|--|---|
| | Isichei, A. O., & Akin-Fajiye, M. A. (2013). Plant invasions in Nigeria. Chapter 20 in: Nigerian Forests: Protection and Sustainable Development. Okon, E, Bown, D. and Isichei, A. (eds). JABU Environmental Symposium Series, Joseph Ayo Babalola University, Ikeji-Arakeji, Nigeria | "the prodigious amount of seeds produced by <i>Tithonia rotundifolia</i> creates larger soil seed bank relative to other species from which the next seasons growth may occur." |

| 803 | Well controlled by herbicides | y |
|-----|--|--|
| | Source(s) | Notes |
| | BioNET-EAFRINE. 2011. <i>Tithonia rotundifolia</i> (Red Sunflower). http://keys.lucidcentral.org/keys/v3/eafrinet/weeds/key/weeds/Media/Html/Tithonia_rotundifolia_(Red_Sunflower).htm . [Accessed 26 Jul 2017] | "Various herbicides can be sprayed onto <i>Tithonia rotundifolia</i> for effective control. When using any herbicide always read the label first and follow all instructions and safety requirements. If in doubt consult an expert." |
| | Ayeni, A. O., Agbato, S. O., & Majek, B. A. (1997). Seed depth influence on Mexican sunflower (<i>Tithonia diversifolia</i>) emergence and control. <i>Weed Technology</i> , 11 (3): 417-427 | [Probably Yes. Related taxon controlled effectively with herbicides] "Abstract: Experiments were conducted in pots and in the field to determine the influence of seed depth on seedling emergence pattern and control of Mexican sunflower with or without imazethapyr plus pendimethalin. Mexican sunflower seeds were placed at 0-, 2.5-, 5-, 7.5-, and 10-cm soil depths, and imazethapyr-pendimethalin mixture was applied PRE at 0, 0.05 + 0.65, 0.09 + 1.31, and 0.18 + 2.62 kg ae (+ ai)/ha. Mexican sunflower emergence was 57, 30, 14, 3, and 2% from 0-, 2.5-, 5-, 7.5-, and 10-cm seed depths, respectively. Seedling emergence started 2 to 3 d after planting and continued for 4 to 5 d. At 0- to 5-cm seed depths, 84 to 100% of total seedling emergence occurred within 3 d after the first seedling emerged, but emergence rate was less from 7.5- and 10-cm seed depths. Imazethapyr plus pendimethalin at 0.05 + 0.65 and 0.09 + 1.31 kg/ha had no effect on seedling emergence in Mexican sunflower, but subsequent growth was severely inhibited regardless of seed depth. The herbicide treatments were more injurious to Mexican sunflower seedlings that emerged from 5- to 10-cm depths than to those that emerged from 0 and 2.5 cm. Burying seeds 7.5 cm deep or more is a potential control measure for Mexican sunflower, and the deeper the emergence depth, the more susceptible the seedling is to imazethapyr plus pendimethalin. Nomenclature: Imazethapyr, 2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid; pendimethalin, N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine; Mexican sunflower, <i>Tithonia diversifolia</i> (Hemsl.) A. Gray." |

| 804 | Tolerates, or benefits from, mutilation, cultivation, or fire | n |
|-----|---|--|
| | Source(s) | Notes |
| | Muoghalu, J. I. (2008). Growth, reproduction and resource allocation of <i>Tithonia diversifolia</i> and <i>Tithonia rotundifolia</i> . <i>Weed Research</i> , 48(2), 157-162 | "Basal stems of <i>T. diversifolia</i> that were left after slashing the shoot (coppiced) resprouted profusely, while those of <i>T. rotundifolia</i> did not. The potted stem cuttings of <i>T. diversifolia</i> sprouted from the buds, but those of <i>T. rotundifolia</i> did not." ... " <i>T. rotundifolia</i> reproduces only sexually as evidenced by the failure of the slashed stem or stem cuttings to sprout." |

| Qsn # | Question | Answer |
|-------|--|---|
| 805 | Effective natural enemies present locally (e.g. introduced biocontrol agents) | |
| | <p style="text-align: center;">Source(s)</p> <p>Simelane, D. O., Mawela, K. V., & Fourie, A. (2011). Prospective agents for the biological control of <i>Tithonia rotundifolia</i> (Mill.) SF Blake and <i>Tithonia diversifolia</i> (Hemsl.) A. Gray (Asteraceae) in South Africa. <i>African Entomology</i>, 19(2), 443-450</p> | <p style="text-align: center;">Notes</p> <p>[Unknown for the Hawaiian Islands] "Starting in 2007, two weedy sunflower species, <i>Tithonia rotundifolia</i> (Mill.) S.F.Blake and <i>Tithonia diversifolia</i> (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 for <i>T. rotundifolia</i>, and three of these are currently undergoing host-specificity and performance evaluations in South Africa. Two leaf-feeding beetles, <i>Zygogramma signatipennis</i> (Stål) and <i>Zygogramma piceicollis</i> (Stål) (Coleoptera: Chrysomelidae), are the most promising biological control agents for <i>T. rotundifolia</i>: preliminary host-specificity trials suggest that they are adequately host-specific. The stem-boring beetle, <i>Lixus fimbriolatus</i> Boheman (Coleoptera: Curculionidae), is also highly damaging to <i>T. rotundifolia</i>, but its host range is yet to be determined. Two other stem-boring beetles, <i>Canidia mexicana</i> Thomson (Coleoptera: Cerambycidae) and <i>Rhodobaenus auctus</i> Chevrolat (Coleoptera: Curculionidae), have also been recorded on <i>T. rotundifolia</i>, and these will be considered for further testing if <i>L. fimbriolatus</i> is found to be unsuitable for release in South Africa. Only two insect species were imported as candidate agents on <i>T. diversifolia</i>, the leaf-feeding butterfly <i>Chlosyne</i> 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, <i>Puccinia enceliae</i> Dietel & Holw. (Uredinales: Pucciniaceae), was found that could potentially have been used as a biological control agent against the <i>Tithonia</i> species, but attempts to culture this rust were unsuccessful."</p> |

Summary of Risk Traits:

High Risk / Undesirable Traits

- Elevation range exceeds 1000 m, demonstrating environmental versatility
- Thrives in tropical climates
- Naturalized on Hawaii Island & widely naturalized elsewhere
- A disturbance and crop weed (but no documented impacts in Hawaiian Islands to date)
- Other *Tithonia* species are invasive weeds
- May be allelopathic
- Possibly unpalatable to deer
- Tolerates half-shade
- Tolerates many soil types
- Forms dense stands in Africa
- Reproduces by seeds
- Hybridizes with other *Tithonia* species
- Reaches reproductive maturity rapidly (2+ months from seed)
- Seeds dispersed by animals, water and on clothing, Also spread in dumped garden waste and contaminated agricultural produce
- Prolific seed production

Low Risk Traits

- Unarmed (no spines, thorns, or burrs)
- Provides fodder for cattle
- Non-toxic
- Ornamental
- Self-incompatible
- Not reported to spread vegetatively
- Herbicides may provide effective control
- Does not tolerate cutting or slashing