**Taxon:** Terminalia arjuna **Family:** Combretaceae

**Common Name(s):** arjun, kumbuk, white murdh

**Synonym(s):** Pentaptera arjuna Roxb. ex DC., Pentaptera glabra Roxb.

**Assessor:** Chuck Chimera **Status:** Assessor Approved **End Date:** 26 Aug 2021

**WRA Score:** 6.0 **Designation:** EVALUATE **Rating:** Evaluate

**Keywords:** Naturalized, Tropical Tree, Unarmed, Fleshy-fruited, Animal-dispersed, Coppices

| Qsn # | Question | Answer Option | Answer |
|---|---|---|---|
| 101 | Is the species highly domesticated? | y=-3, n=0 | n |
| 102 | Has the species become naturalized where grown? | | |
| 103 | Does the species have weedy races? | | |
| 201 | Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical" | (0-low; 1-intermediate; 2-high) (See Appendix 2) | High |
| 202 | Quality of climate match data | (0-low; 1-intermediate; 2-high) (See Appendix 2) | High |
| 203 | Broad climate suitability (environmental versatility) | y=1, n=0 | y |
| 204 | Native or naturalized in regions with tropical or subtropical climates | y=1, n=0 | y |
| 205 | Does the species have a history of repeated introductions outside its natural range? | y=-2, ?=-1, n=0 | y |
| 301 | Naturalized beyond native range | y = 1*multiplier (see Appendix 2), n= question 205 | y |
| 302 | Garden/amenity/disturbance weed | | |
| 303 | Agricultural/forestry/horticultural weed | n=0, y = 2*multiplier (see Appendix 2) | n |
| 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 | y=1, n=-1 | n |
| 405 | Toxic to animals | y=1, n=0 | n |
| 406 | Host for recognized pests and pathogens | y=1, n=0 | n |
| 407 | Causes allergies or is otherwise toxic to humans | y=1, n=0 | n |
| 408 | Creates a fire hazard in natural ecosystems | y=1, n=0 | n |
| 409 | Is a shade tolerant plant at some stage of its life cycle | | |

| 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 | n |
| 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 | >3 |
| 701 | Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas) | y=1, n=-1 | n |
| 702 | Propagules dispersed intentionally by people | y=1, n=-1 | y |
| 703 | Propagules likely to disperse as a produce contaminant | y=1, n=-1 | n |
| 704 | Propagules adapted to wind dispersal | y=1, n=-1 | n |
| 705 | Propagules water dispersed | y=1, n=-1 | y |
| 706 | Propagules bird dispersed | | |
| 707 | Propagules dispersed by other animals (externally) | | |
| 708 | Propagules survive passage through the gut | | |
| 801 | Prolific seed production (>1000/m2) | | |
| 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** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | [No evidence of domestication] "Selection and breeding has been limited for T. arjuna. Genetic variation has been evaluated with respect to vegetative characters such as height, number of branches per plant, length of branches, number of leaves per branch, length and breadth of leaves and leaf yield per plant in an 8-year-old plantation established in Bihar, India for sericulture (Srivastava et al., 1993). According to the results, leaf yield per plant, number of leaves per branch and height are suggested as effective parameters for selection" |

| | | |
|---|---|---|
| **102** | **Has the species become naturalized where grown?** | |
| | **Source(s)** | **Notes** |
| | WRA Specialist. (2021). Personal Communication | NA |

| | | |
|---|---|---|
| **103** | **Does the species have weedy races?** | |
| | **Source(s)** | **Notes** |
| | WRA Specialist. (2021). 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** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna is native to central and southern India and Sri Lanka (Ram Parkash and Hocking, 1986; Philcox, 1995; Trimen, 1974; Chadha, 1976; Lemmens and Wilijarni-Soetjipto, 1991). " |

| | | |
|---|---|---|
| **202** | **Quality of climate match data** | **High** |
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | |

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

| Qsn # | Question | Answer |
|---|---|---|
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | [Elevation range exceeds 1000 m. Demonstrates environmental versatility in tropical climates] "T. arjuna is found on a wide range of semi-arid and sub-humid tropical sites up to 1500 m altitude. The species primarily occurs in areas with a mean annual rainfall between 750 and 1900 mm, although exceptional populations occurs in areas with as little as 500 mm and as much as 3800 mm annual rainfall. It principally occurs in areas with 2-4 months dry season (less than 50 mm rainfall per month), although it tolerates both uniform and bimodal rainfall regimes (Vivekanandan, 1978). The species is adapted to a wide range of temperatures, ranging from -1°C to 47°C. However, seedlings of T. arjuna are not frost tolerant, thus it is not ideally suitable for areas where the temperature falls below 0°C (Gupta, 1993; Ram Parkash and Hocking, 1986; Troup and Joshi, 1984; Chadha, 1976)." |

| 204 | Native or naturalized in regions with tropical or subtropical climates | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna is native to central and southern India and Sri Lanka (Ram Parkash and Hocking, 1986; Philcox, 1995; Trimen, 1974; Chadha, 1976; Lemmens and Wilijarni-Soetjipto, 1991). " |

| 205 | Does the species have a history of repeated introductions outside its natural range? | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna has been commonly used throughout much of India and Sri Lanka as a roadside, shade and ornamental tree. It has also been widely planted in India to rear tasar silkworms. The species has also been planted in Indonesia, Kenya, Malaysia, Mauritius, Pakistan and Thailand, at low elevations, mainly as a roadside or ornamental tree (Troup and Joshi, 1984; Chadha, 1976; Lemmens and Wilijarni-Soetjipto, 1991)." |

| 301 | Naturalized beyond native range | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Bheemalingappa, M., Naik, M. C., Prasad, K., Babu, M. S., Ganeshaiah, K. N., & Rao, B. R. P. (2015). Seven angiosperm species, new records for Andaman & Nicobar Islands, India. Indian Journal of Forestry, 38(1), 71-73 | "Ecology: Occasional, along the sea coast. Introduced? Found naturalized along sea coast and interior evergreen forest." |
| | Schmelzer, G.H. & Gurib-Fakim, A. (Eds.). (2013). Plant Resources of Tropical Africa 11(1). Medicinal Plants 2. PROTA Foundation, Wageningen, Netherlands | "In Africa it is recorded as being planted and sometimes naturalized in several countries. However, the distribution is incompletely known and it probably occurs in other countries as well." |
| | 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 | "More than 700 arjuna seedlings were planted between 1921 and 1931 in Oahu forest reserves, and hikers and hunters occasionally come across these trees or their distinctive 5-winged fruit." [But not documented to be naturalized in the Hawaiian Islands] |

| Qsn # | Question | Answer |
|---|---|---|
| | Kueffer, C. & Mauremootoo, J. (2004). Case studies on the status of invasive woody plant species in the Western Indian Ocean 3. Mauritius (islands of Mauritius and Rodrigues). Working Paper FBS/4-3E. FAO, Rome, Italy | "Some experts suggested additional invasive woody plant species for Mauritius and Rodrigues. These species have been categorized as non-consensus species (Table 2). They should be monitored carefully." ... "Terminalia arjuna has a tendency to naturalize." |
| | Gann GD, Stocking CG and Collaborators. (2001-2021). Floristic Inventory of South Florida Database Online. The Institute for Regional Conservation. Delray Beach, Florida. https://regionalconservation.org. [Accessed 25 Aug 2021] | "SOUTH FLORIDA Native Status: Not Native, Naturalized" |
| | Imada, C. (2019). Hawaiian Naturalized Vascular Plants Checklist (February 2019 update). Bishop Museum Technical Report 69. Bishop Museum, Honolulu, HI | Not documented to be naturalized in the Hawaiian Islands as of February 2019 |

| 302 | Garden/amenity/disturbance weed | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Enloe, S. F., Langeland, K., Ferrell, J., Sellers, B. and MacDonald, G. (2018). Integrated Management of Non-Native Plants in Natural Areas of Florida. SP 242. Revised. University of Florida, IFAS, Gainesville, FL | "Treatment: Cut stump: 50% Garlon 3A. Basal bark: 10% Garlon 4. Comments: The Indian almond is deciduous and invades coastal habitats, hammocks, and disturbed sites; arjun tree and Australian almond invade hammock interiors and margins." |
| | Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall | [Cited as naturalized and/or weedy in some introduced locations. Impacts in the listed references has not been corroborated] "References: pantropics-W-22, United States of America-W-179, Mozambique-nC-943, Cuba-N-1505, Sri Lanka-ZD-1020, Cuba- NI-2055, Cuba-W-1977." |
| | University of Florida, IFAS. (2021). Assessment of Non-Native Plantsin Florida's Natural Areas. https://assessment.ifas.ufl.edu/. [Accessed 26 Aug 2021] | [Terminalia arjuna] "Not a problem species (un-documented)" |
| | WRA Specialist. (2021). Personal Communication | Contradictory evidence for invasiveness of this species reported from Florida. Enloe et al. (2018) report that it "invade hammock interiors and margins", but the UF IFAS Assessment of Non-Native Plantsin Florida's Natural Areas website lists it as "Not a problem species". |

| 303 | Agricultural/forestry/horticultural weed | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall | No evidence |

| Qsn # | Question | Answer |
|---|---|---|
| **304** | **Environmental weed** | |
| | **Source(s)** | **Notes** |
| | Kueffer, C. & Mauremootoo, J. (2004). Case studies on the status of invasive woody plant species in the Western Indian Ocean 3. Mauritius (islands of Mauritius and Rodrigues). Working Paper FBS/4-3E. FAO, Rome, Italy | "Some experts suggested additional invasive woody plant species for Mauritius and Rodrigues. These species have been categorized as non-consensus species (Table 2). They should be monitored carefully." ... "Terminalia arjuna has a tendency to naturalize." [A non-consensus species with no evidence of detrimental environmental impacts documented to date] |
| | Enloe, S. F., Langeland, K., Ferrell, J., Sellers, B. and MacDonald, G. (2018). Integrated Management of Non-Native Plants in Natural Areas of Florida. SP 242. Revised. University of Florida, IFAS, Gainesville, FL | "Treatment: Cut stump: 50% Garlon 3A. Basal bark: 10% Garlon 4. Comments: The Indian almond is deciduous and invades coastal habitats, hammocks, and disturbed sites; arjun tree and Australian almond invade hammock interiors and margins." [Invades natural areas with potential negative impacts] |

| 305 | **Congeneric weed** | **y** |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Enloe, S. F., Langeland, K., Ferrell, J., Sellers, B. and MacDonald, G. (2018). Integrated Management of Non-Native Plants in Natural Areas of Florida. SP 242. Revised. University of Florida, IFAS, Gainesville, FL | "Comments: The Indian almond is deciduous and invades coastal habitats, hammocks, and disturbed sites" |
| | Global Invasive Species Database. (2021). Species profile: Terminalia catappa. http://www.iucngisd.org/gisd/. [Accessed 26 Aug 2021] | "Terminalia catappa is a native plant of Asia that has escaped from cultivation. Due to its ability to cope with sandy, well draining soil, and salt spray it is often found on coastal regions. It is considered invasive in Florida, United States, and several Carribean Islands, including Montserrat, Puerto Rico and the Cayman Islands. Its seeds are highly bouyant which allows it disperse vast distances however they are highly edible so are eaten by bats, crabs and humans. However despite its potential as being an invasive species it is being considered for multiple applications. Due to its extensive and deep-rooting structure it is considered a possible species to use as a dune retention species against proposed climate change and sea-level rise, and in Brazil it is also being considered a potential cultivar to use in bio-fuel creation." |

| Qsn # | Question | Answer |
|---|---|---|
| 401 | **Produces spines, thorns or burrs** | **n** |
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna is a fluted tree with a large, spreading crown and drooping branches. Under natural conditions, the tree grows to a height up to 30 m (sometimes up to 60 m) with a diameter at breast height (dbh) up to 2-2.5 m. The bole is straight, in most cases clear of branches for half of the total height and usually buttressed." ... "The leaves are simple, opposite to sub-opposite, coriaceous, oblong to ovate lanceolate, to subobovate, cuneate, rounded to occasionally narrowly subtruncate at base, obtuse, shortly apiculate or mucronate at apex. Shortly pale sericeous when young, soon becoming glabrous but not shiny on both sides. Pale dull-green, minutely verrucose. The margins are shallow crenate to serrate. Lamina is 8-25 x 5-9 cm, arcuate 10-20 pairs of pellucid veins, leaves exstipulate. The petiole is short (2-4 cm long), sericeous, with 2 (or 1) prominent glands at petiole apex (Jayaweera, 1980; Philcox, 1995; Trimen, 1974; Troup and Joshi, 1984; Chadha, 1976)." |

| 402 | **Allelopathic** | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Orwa C,et al. (2009). Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 26 Aug 2021] | "Intercropping: T. arjuna is an agroforestry species, often intercropped with coconut and citrus. It is also an excellent shade tree, especially in coffee plantations." [Suggests no evidence of allelopathy] |
| | Gulzar, A., & Siddiqui, M. B. (2013). Evaluation for allelopathic impact of Terminalia arjuna (Roxb.) wight and arn bark against Cassia sophera. African Journal of Agricultural Research, 8(39): 4937-4940. | [Possibly, Unknown from field conditions] "Allelopathic performance of the aqueous extract of bark of Terminalia arjuna on Cassia sophera was evaluated under laboratory conditions. Aqueous extract of bark were prepared at different concentrations of 2, 4, 6, 8 and 10%. Ten seeds of test plant were kept for germination in sterilized Petri dishes of 9 cm diameter lined double with double layer of blotting paper moistened with different concentrations of aqueous extract (2 to 10%) and distilled water. Each treatment had three replicates. The experiment was recorded for 15 days. It was observec that aqueous extract reduced the germination, plumule and radicle length. Phytotoxicity of extract depends upon concentration. However, extract at higher concentration (10%) had strong inhibitory effect on germination and seedling growth of test species. From this we can suggest that T. arjuna may be a source of natural weedicide and can be used for controlling invasive plants." |

| 403 | **Parasitic** | **n** |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna is a fluted tree with a large, spreading crown and drooping branches." [Combretaceae. No evidence] |

| 404 | **Unpalatable to grazing animals** | **n** |
|---|---|---|
| | **Source(s)** | **Notes** |

| Qsn # | Question | Answer |
|---|---|---|
| | Orwa C,et al. (2009). Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 26 Aug 2021] | "Fodder: It is widely planted for raising tassar silkworm and livestock fodder in India where leaves are heavily lopped. The leaves contain 9 -11% crude protein and 14-20% crude fibre." |
| | Schmelzer, G.H. & Gurib-Fakim, A. (Eds.). (2013). Plant Resources of Tropical Africa 11(1). Medicinal Plants 2. PROTA Foundation, Wageningen, Netherlands | "The fruits and leaves are widely used as fodder for livestock and the leaves for rearing tasar silkworms." |

| 405 | Toxic to animals | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Schmelzer, G.H. & Gurib-Fakim, A. (Eds.). (2013). Plant Resources of Tropical Africa 11(1). Medicinal Plants 2. PROTA Foundation, Wageningen, Netherlands | "The fruits and leaves are widely used as fodder for livestock and the leaves for rearing tasar silkworms." [No evidence] |
| | 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 | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna does not suffer from any serious pests or diseases. However, incidence of powdery mildew caused by Phyllactinia terminalae and white fibrous rot due to Polystictus affinis have been reported. Larvae of Apoderus tranquebaricus feed inside rolled leaves, whilst larvae of Gelasma goniaria and Lymantria mathura cause defoliation of the plant (Ram Parkash and Hocking, 1986; Chadha, 1976). Gupta (1993) has reported the presence of Ceroplastes ceriferus (white wax insects) on the leaves." |

| 407 | Causes allergies or is otherwise toxic to humans | n |
|---|---|---|
| | **Source(s)** | **Notes** |

| Qsn # | Question | Answer |
|---|---|---|
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | [Widely used with no reports of acute toxicity or allergic reactions] "T. arjuna has been widely used in Ayurvedic medicine for the treatment of cancer, dermatological and gynaecological complaints, heart diseases and urinary disorders. The bark is acrid, an astringent and tonic, and is useful in treatment of high blood pressure and ulcers. The cancer cell growth inhibitory constituent (luteolin) has been isolated from bark, stem and leaves of T. arjuna, rationalizing the use of T. arjuna in traditional cancer treatments (Pettit et al., 1996). Luteolin has also been shown to have specific anti-bacterial activity against Neisseria gonorrhoea. Reviews of the medicinal uses and pharmacological properties of various parts of T. arjuna are given by Dwivedi and Udupa (1989) and Kumar and Prabhakar (1987). The bark, primarily, and fruit are used as tanning and dyeing material (Gupta, 1993; Chadha, 1976; Watt, 1908). The tannage can be used for making fine upper leather and excellent sole leather of light-brown or buff colour with a red tint. The bark contains 20-24% tannin and is remarkable for the large amount of lime (calcium carbonate) it contains. It is often burnt to produce lime for chewing with betel (Perera and Jain, 1992). The bark is also used to assist precipitation of mud from turbid water (Lemmens and Wilijarni-Soetjipto, 1991). T. arjuna trees exude a red resin." |
| | Wagstaff, D.J. (2008). International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL | No evidence |

| 408 | Creates a fire hazard in natural ecosystems | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Orwa C,et al. (2009). Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 26 Aug 2021] | "It occurs naturally along banks of streams and rivers and seasonally dry water courses at low elevations. The species is a characteristic component of dry tropical riverine forests and tropical moist and dry deciduous forests" [No evidence of increased fire risk from this tree, and riparian habitats may be less likely to burn, even in dry forests] |

| 409 | Is a shade tolerant plant at some stage of its life cycle | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Sheikh, M. I. (1993). Trees of Pakistan. Pictorial Printing (Pvt) Ltd., Islamabad | "A shade tolerant tree that grows on a variety of moist sites if they are well drained." |
| | Orwa C,et al. (2009). Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 26 Aug 2021] | "Heavy shade is also injurious to seedlings resulting in die-back for several years, again leading to a bushy tree." |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna is a moderately shade-bearing tree, but does not tolerate dense overhead shade (Kadambi, 1954; Troup and Joshi, 1984)." |

| 410 | Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island) | y |
|---|---|---|
| | **Source(s)** | **Notes** |

| Qsn # | Question | Answer |
|---|---|---|
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna occurs on a variety of soils, providing a good moisture supply is available (Gupta, 1993; Ram Parkash and Hocking, 1986; Chadha, 1976). It grows well on fertile, neutral (pH 6.5 - 7.0) soils, especially loose, moist, alluvial loam with good water supply and drainage. T. arjuna appears to be a tolerant species to alkaline and sodic soils with pH up to 9 (Banwari Lal and Lal, 1995; Sharma et al., 1994; Kalyan Singh, 1994) and has the ability to ameliorate soil pH in sodic soils (Singh et al., 1992). " |

| 411 | Climbing or smothering growth habit | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna is a fluted tree with a large, spreading crown and drooping branches. Under natural conditions, the tree grows to a height up to 30 m (sometimes up to 60 m) with a diameter at breast height (dbh) up to 2-2.5 m." |

| 412 | Forms dense thickets | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Schmelzer, G.H. & Gurib-Fakim, A. (Eds.). (2008). Plant Resources of Tropical Africa 11(1). Medicinal Plants 1. PROTA Foundation, Wageningen, Netherlands | "In Africa it is recorded as being planted and sometimes naturalized in several countries." [No evidence in Africa to date] |
| | Punde, S. (2007). Prioritising areas for Forest Conservation in the Konkan region of the Western Ghats hotspot – a pilot study. BES, London & AERF, Pune, India | "Table 2: Some identified threatened vegetation types of the Konkan region" ... "Dense or medium dense stands of large, old growth riparian tree species including Terminalia arjuna, Pongamia pinnata occasionally interspersed with Mangifera indica and/or Lagerstroemia microcarpa." [A component of dense stand formation, but no evidence that T. arjuna forms monocultures] |

| 501 | Aquatic | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "Under natural conditions, the species grows on the banks of streams, rivers and canals. The root mass of the species helps to reduce soil erosion on the banks." |

| 502 | Grass | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna is a large and relatively fast-growing tree." |

| 503 | Nitrogen fixing woody plant | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "Family: Combretaceae" |

| Qsn # | Question | Answer |
|---|---|---|
| **504** | **Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)** | **n** |
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna is a fluted tree with a large, spreading crown and drooping branches. Under natural conditions, the tree grows to a height up to 30 m (sometimes up to 60 m) with a diameter at breast height (dbh) up to 2-2.5 m." |

| | | |
|---|---|---|
| **601** | **Evidence of substantial reproductive failure in native habitat** | **n** |
| | **Source(s)** | **Notes** |
| | Schmelzer, G.H. & Gurib-Fakim, A. (Eds.). (2013). Plant Resources of Tropical Africa 11(1). Medicinal Plants 2. PROTA Foundation, Wageningen, Netherlands | "In India Terminalia arjuna has a wide-distribution and is relatively common. However, in several localities wild populations are threatened by unsustainable harvesting of the bark." |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | No evidence |

| | | |
|---|---|---|
| **602** | **Produces viable seed** | **y** |
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "Natural regeneration occurs in forests through self-seeding where the seeds accumulate in loose alluvial soil along stream banks of sub-humid to humid areas (Chadha, 1976). Natural regeneration rarely occurs in semi-arid habitats due to lack of moisture. Seed germination takes place early in the rainy season. If seeds are exposed to the sun, they do not readily germinate. T. arjuna is initially a slow-grower, but later grows quickly." |
| | Kumar, H., Lal, S. B., Wani, A. M., Umrao, R., Khare, N., & Kerketta, N. S. (2017). Seed Size Correlates with Germination Traits in Terminalia arjuna Genotypes. Int. J. Curr. Microbiol. App. Sci, 6(8), 2896-2903 | "Seed size emerged as a governing characteristic for germination parameters and seedling establishment owing to best evolutionary traits of plant which impart major contribution in genetic diversity. Large size increased germination rate and seedling survival, accelerated germination timing, and enhanced seedling growth. Present experiment is carried out to assess the seed size correlates with germination characteristics in Terminalia arjuna. The findings suggest that the seedling vigour is a fixed positive function of seed size needs to be reconsidered. Germination of large seeds recorded slightly higher than small size and ranges from 68.33 to 43.33%. Mean daily germination value ranged between 1.81 to 2.85, Peak value of germination ranged between 3.15 to 4.59, Germination value ranged between 5.79to 13.67 and germination speed ranged between3.71 to 5.88. The existence of conflicting selection might explain the occurrence of an optimal seed size in some plant species without invoking a seed number-size trade-off. Hence, it is recommended to use only medium and large size seeds for growing, because they do result in higher germination behavior and seedling establishment." |

| | | |
|---|---|---|
| **603** | **Hybridizes naturally** | |

| Qsn # | Question | Answer |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Sarwat, M., Das, S., & Srivastava, P. S. (2011). AFLP and SAMPL markers for characterization of genetic diversity in Terminalia arjuna: a backbone tree of Tasar silk industry. Plant Systematics and Evolution, 293(1-4): 13-23 | "Hybridization or evolutionary divergence could be one of the reasons for such a high degree of affinity and intergrading among various varieties and forms of T. arjuna complexes." [Unknown if natural hybridization presently occurs] |
| | Deshmukh, V., Thakare, P., Chaudhari, U. S., Gawande, P. A., & Undal, V. S. (2009). Assessment of Genetic Diversity among Terminalia Species Using RAPD Markers. Global Journal of Biotechnology & Biochemistry, 4(2): 70-74. | "On dendrogram T. arjuna and T. tomentosa were placed in separate clusters; can be used as parents in tree breeding programme, as some spontaneous hybrids of these two species are available in field Srivastav et al. [26], Srivastava et al.[9]. Thawaites (quoted by Hooker [4]) were opinion to merge T. arjuna and T. tomentosa in to single species, but present results strongly regret to do so, as both were found to be genetically much divergent species showing least (39.3%) of genetic similarity." [Possibly Yes] |
| | Kumar, R., Deka, M., Yadav, H., & Sahay, A. (2015). Crossability Studies in Terminalia Arjuna and T. Tomemtosa. International Journal of Applied Biology and Pharmaceutical Technology 6(3): 211-216 | [Artificial hybrids possible] "T. arjuna and T. tomentosa come under multipurpose tree category and are of immense economic importance besides being the primary food plants of Tasar silkworm Antheraea mylitta D. Blooming occurs from second week of May in T. arjuna and last week of May in T. tomentosa. Number of flowers per raceme range between 41 in accession 235 to 58 in accession 702 of T. arjuna and 53 (acc.531) to 73 (acc.501) of T. tomentosa. Fruit set per cent ranged between 2.0 in accessions 235 and 236 to 4.00 in accession 533 of T. arjuna. Per cent fruit set was 3.0 to 3.2 in accessions 501 and 531, respectively of T. tomentosa under open pollination condition. There was no fruit set in un - pollinated and covered racemes. Days required for fruit initiation in T. arjuna x T. arjuna combination varied between 12 to 14 days and fruit set was 1.8 to 2.5 percent. In T.arjuna x T.tomentosa combinations initiation of fruit set took 10 (acc.701 x acc.501) to 14 (acc.533 x acc.531) days and fruit set was 1.5 to 2.4 per cent. Present studies indicate that inter-specific hybridization is possible in T. arjuna and T. tomentosa. New hybrid varieties can be developed through inter-specific hybridization having higher yield in comparison to the existing genotypes." |

| 604 | Self-compatible or apomictic | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Kubitzki, K., Bayer, C. 7 Stevens, P.F. (2007). The Families and Genera of Vascular Plants: Volume IX. Flowering Plants. Eudicots. Springer-Verlag, Berlin, Heidelberg, New York | "In India, Srivastava (1993) found that four species of Terminalia were self-incompatible, and were visited by these orders of insects for both pollen and nectar." {Species studied include T. arjuna, T. tomentosa, T. paniculata and T. chebula] |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "Siddiqui et al. (1993; 1994) also report information on genetic variation and heritability for leaf characters in selected, open-pollinated, plus tree genotypes of T. arjuna in India. Polyembryony in T. arjuna has been observed by Sinha et al. (1993) and it has been classified as a polygamous species. It is reported to be an insect pollinated species (Srivastava, 1993). However, little is known about its reproductive biology and provenance variation." |

| Qsn # | Question | Answer |
|---|---|---|
| | Chauhan, S., Sharma, S. B., & Chauhan, S. V. S. (2008). Reproductive Biology of Terminalia arjuna (Roxb.) Wt. & Arn. Indian Forester, 134(11), 1468-1478 | [Exhibits facultative xenogamy, but capable of some fruit set through self-pollination] "Terminalia arjuna, a valuable medicinal tree. The bark of the tree is not only used to lower blood pressure but is extremely useful in cardio-vascular diseases. It, flowers during April-July. The flowers are hermaphrodite, actinomorphic, and epigynous and each has one whorl of gamotepalous perianth. They are borne on pendulous terminal and axillary spikes. Flowers open daily during 0500-0630 h and offer both pollen and nectar as floral rewards. Foragers include honeybees, butterflies, wasps, flies, ants and sunbirds. The fruiting behaviour indicates that this species shows facultative xenogamy, but mostly eliminates growing fruits from self-pollinated flowers. The facultative breeding system is considered to be adaptive for T. arjuna for colonization as it facilitates fruit-set through self-pollination. Natural fruit-set is 48%. The winged and woody fruits are dispersed by wind and birds." |

| 605 | Requires specialist pollinators | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "Inflorescences are short axillary spikes or small terminal panicles, 9-13 cm long with 2.5-6 cm long inflorescence branches, rachis short, white, pubescent, lower receptacle 0.8-1.5 mm long, short sericeous, upper receptacle 1.5-1.75 mm long, glabrous except at base where slightly pubescent. Flowers are small, cup-shaped, regular, sessile, polygamous, white, creamy or greenish-white and strongly honey-scented. Bracteoles linear, lanceolate, shorter than flowers, caducous. Sepals 5, fused in to a tube adnate to the ovary; petals absent. Calyx lobes 0.8-1.8 x 1-1.5 mm, glabrous, minutely verrucose, distinct median nerve not reflexed at maturity. Stamens 10, distinct, five often longer, anthers 0.4-0.6 mm long with 3.5 mm glabrous filaments, inserted on the calyx tube outside the annular epigynous hairy disk. Ovary inferior, unilocular with 2 or 3 pendulous ovules, 1-1.5 mm long, glabrous style. " ... "It is reported to be an insect pollinated species (Srivastava, 1993)." |
| | Srivastava, P.K. (1993). Pollination mechanisms in genus Terminalia Linn. Indian Forester 119:147–150 | "Observations on pollination were recorded for 2-3 selected trees of each of 4 species of Terminalia (T. arjuna, T. tomentosa, T. paniculata and T. chebula) at the Piska Nagri farm of the Central Tasar Research and Training Institute, Bihar, in 1987-89." ... "It is concluded that insect pollination is important in Terminalia. Some 22 insect species were collected over the Terminalia flowers: 6 Hymenoptera, 6 Lepidoptera, 6 Diptera, 2 Hemiptera and 2 Coleoptera. Details of these are tabulated, indicating feeding habit (leaf/nectar/pollen) and month/s of collection. Pollen foragers were generally more efficient pollinators than nectar foragers, and bees were important in pollination." |
| | Chauhan, S., Sharma, S. B., & Chauhan, S. V. S. (2008). Reproductive Biology of Terminalia arjuna (Roxb.) Wt. & Arn. Indian Forester, 134(11), 1468-1478 | "The flowers are hermaphrodite, actinomorphic, and epigynous and each has one whorl of gamotepalous perianth. They are borne on pendulous terminal and axillary spikes. Flowers open daily during 0500-0630 h and offer both pollen and nectar as floral rewards. Foragers include honeybees, butterflies, wasps, flies, ants and sunbirds." |

| Qsn # | Question | Answer |
|---|---|---|
| **606** | **Reproduction by vegetative fragmentation** | **y** |
| | **Source(s)** | **Notes** |
| | Sheikh, M. I. (1993). Trees of Pakistan. Pictorial Printing (Pvt) Ltd., Islamabad | "It can be reproduced both from seed and by vegetative means." |
| | Orwa C,et al. (2009). Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 26 Aug 2021] | "It produces root suckers and is suitable for pollarding." |
| | Schmelzer, G.H. & Gurib-Fakim, A. (Eds.). (2013). Plant Resources of Tropical Africa 11(1). Medicinal Plants 2. PROTA Foundation, Wageningen, Netherlands | "Terminalia arjuna can be propagated by seed and also by root-suckers, stumps and air-layering." |

| 607 | Minimum generative time (years) | >3 |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "In India T. arjuna start bearing fruits 6-7 years after planting." |

| 701 | Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas) | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Orwa C,et al. (2009). Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 26 Aug 2021] | "Fruit 2.5-6 x 1.8-2.8 cm long, obovoid-oblong, dark brown to reddish-brown fibrous woody, indehiscent drupe, glabrous with 5-7 equal thick narrow stiff-wings and striated with numerous upwards-curved veins." [Inadvertent dispersal unlikely, large fruits with no means of external attachment] |

| 702 | Propagules dispersed intentionally by people | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | 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 | "More than 700 arjuna seedlings were planted between 1921 and 1931 in Oahu forest reserves, and hikers and hunters occasionally come across these trees or their distinctive 5-winged fruit." |
| | Schmelzer, G.H. & Gurib-Fakim, A. (Eds.). (2013). Plant Resources of Tropical Africa 11(1). Medicinal Plants 2. PROTA Foundation, Wageningen, Netherlands | "Terminalia arjuna is native to India and Sri Lanka but has been planted as an ornamental and roadside tree throughout the tropics of the Old and New World." |

| 703 | Propagules likely to disperse as a produce contaminant | n |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Orwa C,et al. (2009). Agroforestree Database: a tree reference and selection guide version 4.0. http://www.worldagroforestry.org. [Accessed 26 Aug 2021] | "Fruit 2.5-6 x 1.8-2.8 cm long, obovoid-oblong, dark brown to reddish-brown fibrous woody, indehiscent drupe, glabrous with 5-7 equal thick narrow stiff-wings and striated with numerous upwards-curved veins." [No evidence of produce contamination, and fruits fairly large] |

| 704 | Propagules adapted to wind dispersal | n |
|---|---|---|

| Qsn # | Question | Answer |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Nakar, R. N., Jadeja, B. A., Chovatiya, V. P., & Mandavia, C. (2017). Qualitative and Quantitative Seed Characteristics Diversity from Girnar Reserve Forest, Gujarat, India. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 87(1), 147-159 | "Seeds of Terminalia arjuna (Roxb.) W. & A were largest among all species by showing highest length (3.19 cm), highest width (2.56 cm), highest thickness (2.64 cm) and average highest seed volume (21.48 cm3)." [Although fruit are winged, large seed size makes wind dispersal unlikely] |
| | Nama, K. S., & Choudhary, K. (2013). Dispersal pattern of some tree species of Mukundara Hills National Park. International Journal of Pure & Applied Bioscience 1(2), 24 -30 | "Table-1: Dispersal Pattern in Various Tree Species" ... "Terminalia arjuna - DM - Dispersal Medium = Zoochorous" [Animal dispersed] |

| 705 | Propagules water dispersed | y |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "It occurs naturally along banks of streams and rivers and seasonally dry water courses at low elevations. " ... "Natural regeneration occurs in forests through self-seeding where the seeds accumulate in loose alluvial soil along stream banks of sub-humid to humid areas (Chadha, 1976). " [Suggests seed dispersal is facilitated by water] |

| 706 | Propagules bird dispersed | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Vendan, S.E. & Kaleeswaran, B.. (2011). Plant dispersal by Indian flying fox Pteropus giganteus in Madurai region, India. Elixir Bio-Diversity 30: 1810-1813 | "In the present study, the seeds of the following species were found to be dispersed by P. giganteus " [T. arjuna dispersed by flying foxes. Seeds could theoretically also be dispersed by birds large enough to consume fruit & swallow the seeds, but the Hawaiian Islands currently lacks large frugivorous bird species. Large game birds may be able to disperse seeds] |

| 707 | Propagules dispersed by other animals (externally) | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Kanoje, R. S. (2008). Nesting sites of Indian giant squirrels in Sitanadi Wildlife Sanctuary, India. Current Science, 95 (7): 882-884 | "Table 2. Food habits of the Indian giant squirrel at Sitanadi Wildlife Sanctuary" ... "Terminalia arjuna - Part consumed = Fruit" [Squirrels may carry disperse seeds externally when transporting & consuming fruit. In the Hawaiian Islands, rodents, & mongoose may disperse seeds in this manner] |

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

| Qsn # | Question | Answer |
|---|---|---|
| | Vendan, S.E. & Kaleeswaran, B.. (2011). Plant dispersal by Indian flying fox Pteropus giganteus in Madurai region, India. Elixir Bio-Diversity 30: 1810-1813 | [Fruits in this study were half-eaten by bats. Unknown if relatively large seeds would be swallowed whole or if they would survive gut passage intact] "Pteropodids are the most to species which are involved in seed dispersal. The most studied in seed dispersal are extensively carried out in Old World fruit bats. In the present study, the seeds of the following species were found to be dispersed by P. giganteus namely Anacardium occidentale, Borassus flabellifer, Calophyllum inophyllum, Carcia papaya, Eugenia jambolana, Ficus sp., Madhuca indica, Mangifera indica, Murraya koenigi, Nerium indicum, Phoenix dactylifera, Pithecellobium dulce, Polyalthia longifolia, Prosopis juliflora, Psidium guajava, Tamarindus indica, Terminalia arjuna, Terminallia cattappa and Ziziphus sp. Among these M. indica, T. cattappa, M. indica, P. longifolia, B. flabellifer, A. occidentale, P. juliflora, N. indicum, C. nucifera, T. indica, A. indica and P. dactylifera are large-seeded fruits (which were half-eaten) and the rest are small-seeded fruits were dispersed of beneath the day roosts." |

| 801 | Prolific seed production (>1000/m2) | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Schmelzer, G.H. & Gurib-Fakim, A. (Eds.). (2013). Plant Resources of Tropical Africa 11(1). Medicinal Plants 2. PROTA Foundation, Wageningen, Netherlands | "Generally, every third year is a good seed year." [Suggests seed densities would be low or absent in non mast years] |

| 802 | Evidence that a persistent propagule bank is formed (>1 yr) | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | Ravindranath, N. H., Bhat, D. M., & Swamy, V. S. (2004). Nursery Manual for Forest Tree Species. Universities Press, Hyderguda, India | "Seed longevity - Moderately long lived" [Unknown if this refers to field conditions or seed storage] |
| | Horticultural Impex. (2021). Terminalia arjuna. http://www.ehorticulture.com/tree-plants-seeds/medicinal-plants/terminalia-arjuna-detail.html. [Accessed 26 Aug 2021] | "'Seed Longevity Moderate Long Lived (6-12 months)" [Unknown from field conditions] |
| | Royal Botanic Gardens Kew. (2021) Seed Information Database (SID). Version 7.1. http://data.kew.org/sid/ . [Accessed 26 Aug 2021] | "Storage Behaviour: Orthodox?<br>Storage Conditions: No loss in viability after 2 years'hermetic storage at room temperature (Det, 1948); > 3 years (Athaya, 1985)" [Unknown from field conditions] |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "T. arjuna is commonly propagated by seed in India. The mature seeds are viable for 1 year when stored in dry gunny bags or in open or closed glass bottles, however germination rates are then reduced by 10-20% (Athaya, 1985; Ram Parkash and Hocking, 1986; Chadha, 1976). Thus, seeds can be classified as orthodox." |

| 803 | Well controlled by herbicides | y |
|---|---|---|
| | **Source(s)** | **Notes** |

| Qsn # | Question | Answer |
|---|---|---|
| | Enloe, S. F., Langeland, K., Ferrell, J., Sellers, B. and MacDonald, G. (2018). Integrated Management of Non-Native Plants in Natural Areas of Florida. SP 242. Revised. University of Florida, IFAS, Gainesville, FL | "Cut stump: 50% Garlon 3A. Basal bark: 10% Garlon 4." |
| | Langeland, K.A.& Stocker, R.K. (2001). Control of Non-native Plants in Natural Areas of Florida. SP 242. Institute of Food & Agricultural Sciences, University of Florida, Gainesville, FL | "Treatment: Basal bark application of 10% Garlon 4 or cut-stump treatment with 50% Garlon 3A." |

| 804 | **Tolerates, or benefits from, mutilation, cultivation, or fire** | **y** |
|---|---|---|
| | **Source(s)** | **Notes** |
| | CAB International. (2005). Forestry Compendium. CAB International, Wallingford, UK | "- Ability to sucker; coppice; pollard" ... "The species may also be propagated by air-layering, root suckers and stumps (Ram Parkash and Hocking, 1986; Chadha, 1976)." |

| 805 | **Effective natural enemies present locally (e.g. introduced biocontrol agents)** | |
|---|---|---|
| | **Source(s)** | **Notes** |
| | WRA Specialist. (2021). Personal Communication | Unknown |

**Summary of Risk Traits:**

High Risk / Undesirable Traits
• Thrives in tropical climates
• Elevation range exceeds 1000 m, demonstrating some environmental versatility
• Naturalized in Florida, Africa, Mauritius and possibly elsewhere
• Other Terminalia species have become invasive
• Possibly allelopathic
• Adult trees shade tolerant
• Tolerates many soil types
• Can reproduce vegetatively by root suckers and stumps
• Viable seeds dispersed by animals (e.g. flying foxes), water and intentionally by people
• May form a persistent seed bank (unknown from field conditions)
• Able to coppice and resprout after cutting

Low Risk Traits
• Unarmed (no spines, thorns or burrs)
• Fodder tree (palatable to grazing animals)
• Used to raise tassar silkworms
• Non-toxic
• Ornamental
• Seedlings are shade-intolerant
• Mostly self-incompatible (although limited self-pollination has been documented to occur)
• Reaches maturity in 6-7 years

Second Screening Results for Tree/tree-like shrubs

(A) Shade tolerant or known to form dense stands?> Not known to form dense stands. Shade tolerance inconclusive
(B) Bird-dispersed?> Dispersed by flying foxes (no reports of bird-dispersal)
(C) Life cycle < 4 years? No
Outcome = Evaluate Further