

Taxon: <i>Orobanche ramosa</i>	Family: Orobanchaceae
Common Name(s): branched broomrape branching broomrape hemp broomrape	Synonym(s): Phelipanche ramosa (L.) Pomel

Assessor: Assessor	Status: Assessor Approved	End Date: 30 May 2014
WRA Score: 14.0	Designation: H(HPWRA)	Rating: High Risk

Keywords: Obligate Parasite, Agricultural Weed, Prolific Seeder, Seed Bank, Wind-dispersed

Qsn #	Question	Answer Option	Answer
101	Is the species highly domesticated?	y=-3, n=0	n
102	Has the species become naturalized where grown?		
103	Does the species have weedy races?		
201	Species suited to tropical or subtropical climate(s) - If island is primarily wet habitat, then substitute "wet tropical" for "tropical or subtropical"	(0-low; 1-intermediate; 2-high) (See Appendix 2)	Intermediate
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)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	y
304	Environmental weed		
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic	y=1, n=0	n
403	Parasitic	y=1, n=0	y
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals	y=1, n=0	n
406	Host for recognized pests and pathogens		
407	Causes allergies or is otherwise toxic to humans	y=1, n=0	n
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)		
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	y=1, n=-1	y
604	Self-compatible or apomictic	y=1, n=-1	y
605	Requires specialist pollinators	y=-1, n=0	n
606	Reproduction by vegetative fragmentation	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	n
703	Propagules likely to disperse as a produce contaminant	y=1, n=-1	y
704	Propagules adapted to wind dispersal	y=1, n=-1	y
705	Propagules water dispersed	y=1, n=-1	y
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)		
708	Propagules survive passage through the gut	y=1, n=-1	y
801	Prolific seed production (>1000/m ²)	y=1, n=-1	y
802	Evidence that a persistent propagule bank is formed (>1 yr)	y=1, n=-1	y
803	Well controlled by herbicides		
804	Tolerates, or benefits from, mutilation, cultivation, or fire		
805	Effective natural enemies present locally (e.g. introduced biocontrol agents)		

Supporting Data:

Qsn #	Question	Answer
101	Is the species highly domesticated?	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"The chromosome number of <i>O. ramosa</i> is $2n = 24$. In addition to the genetic variability evident in the range of varieties and/or sub-species noted above, there is also evidence for variation between morphologically similar populations associated with particular hosts. Brault et al.(2007) have demonstrated significant variation in the virulence of parasites collected from rape-seed, tobacco and hemp in France, suggesting the development of host-related pathotypes, confirmed by differences in RAPD analysis. Musselman and Parker (1982) had earlier shown similar variation in the host-preference of forms attacking Solanaceae and lettuce."
102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. 2014. Personal Communication	NA
103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. 2014. 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"	Intermediate
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	[Tolerates tropical climates, but prefers temperate climates] " <i>O. ramosa</i> occurs naturally in Mediterranean countries in southern Europe, Africa and the Middle East, extending eastwards to India, Pakistan and China, central Asia and southern Russia but has also been introduced to the USA, Cuba, Central America, Australia, West Africa, East Africa, South Africa and Chile." ... "As - Tropical savannah climate with dry summer - Tolerated" ... "Aw - Tropical wet and dry savanna climate - Tolerated" ... "BW - Desert climate - Tolerated" ... "Cf - Warm temperate climate, wet all year - Preferred" ... "Cs - Warm temperate climate with dry summer Preferred" ... "Cw - Warm temperate climate with dry winter Preferred"
202	Quality of climate match data	High
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	
203	Broad climate suitability (environmental versatility)	y

Qsn #	Question	Answer
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	[Can grow from temperate to tropical climates] "As - Tropical savannah climate with dry summer Tolerated < 60mm precipitation driest month (in summer) and < (100 - [total annual precipitation {mm}/25]) Aw - Tropical wet and dry savanna climate Tolerated < 60mm precipitation driest month (in winter) and < (100 - [total annual precipitation{mm}/25]) BW - Desert climate Tolerated < 430mm annual precipitation Cf - Warm temperate climate, wet all year Preferred Warm average temp. > 10°C, Cold average temp. > 0°C, wet all year Cs - Warm temperate climate with dry summer Preferred Warm average temp. > 10°C, Cold average temp. > 0°C, dry summers Cw - Warm temperate climate with dry winter Preferred Warm temperate climate with dry winter (Warm average temp. > 10°C, Cold average temp. > 0°C, dry winters)"

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	[Tolerates tropical climates, but prefers temperate climates] "O. ramosa occurs naturally in Mediterranean countries in southern Europe, Africa and the Middle East, extending eastwards to India, Pakistan and China, central Asia and southern Russia but has also been introduced to the USA, Cuba, Central America, Australia, West Africa, East Africa, South Africa and Chile." ... "As - Tropical savannah climate with dry summer - Tolerated" ... "Aw - Tropical wet and dry savanna climate - Tolerated" ... "BW - Desert climate - Tolerated" ... "Cf - Warm temperate climate, wet all year - Preferred" ... "Cs - Warm temperate climate with dry summer Preferred" ... "Cw - Warm temperate climate with dry winter Preferred"

205	Does the species have a history of repeated introductions outside its natural range?	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"O. ramosa occurs naturally in Mediterranean countries in southern Europe, Africa and the Middle East, extending eastwards to India, Pakistan and China, central Asia and southern Russia but has also been introduced to the USA, Cuba, Central America, Australia, West Africa, East Africa, South Africa and Chile."

301	Naturalized beyond native range	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"O. ramosa occurs naturally in Mediterranean countries in southern Europe, Africa and the Middle East, extending eastwards to India, Pakistan and China, central Asia and southern Russia but has also been introduced to the USA, Cuba, Central America, Australia, West Africa, East Africa, South Africa and Chile."

Qsn #	Question	Answer
	Cooke, D., Virtue, J., & Jupp, P. 2002. Control of branched broomrape. A literature review. Department of Water, Land and Biodiversity Conservation, Adelaide, Australia	" <i>Orobanche ramosa</i> occurs in native vegetation and as a weed in crops in the Mediterranean region and SW Asia (Musselman, 1991). Within Europe, it is regarded as native in the southern countries including Italy and Greece, but naturalised further north where it is only known from cultivated crops and gardens (Chater & Webb, 1972)."

302	Garden/amenity/disturbance weed	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>O. ramosa</i> does not spread rapidly or aggressively but its introduction in contaminated seed or soil can go undetected, and once introduced it can cause severe damage to important agricultural crops and prove very difficult to eradicate."

303	Agricultural/forestry/horticultural weed	y
	Source(s)	Notes

Qsn #	Question	Answer
	<p>CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc</p>	<p>"The crops most seriously affected by <i>O. ramosa</i> are tomato, aubergine and tobacco, with localized problems on many other crops, especially Brassica spp. Holm et al. (1979) list this species as a 'principal' or 'serious' weed in Egypt, Jordan, Lebanon, Italy, Turkey, Hungary, Nepal and Cuba. Severe problems in tomato have more recently been reported from Cyprus, Sudan and Chile, and from Ethiopia, where the viability of tomato juice factories have been threatened by reduced yields resulting from <i>O. ramosa</i> and <i>O. cernua</i> (Parker, 1988). Losses in yield of tobacco and tomato have been estimated at about 30%, while additional damage is caused in tobacco by effects on quality (Parker and Riches, 1993). In Sudan, losses of 80-100% in tomato and potato yield have been reported (Babiker et al., 1994). Increasing infestation of rapeseed crops is of concern in France (Collin, 1999). Infestation of tomatoes and aubergine by <i>O. ramosa</i> can be especially serious as it may prove uneconomic to continue growing these crops (and many others) for a very long period. Attempts to resume growing a susceptible crop on infested land within 5-7 years are liable to result in immediate re-infestation (Parker and Riches, 1993)." ... "The crops most seriously affected by <i>O. ramosa</i> are tomato, aubergine and tobacco, with localized problems on many other crops, especially Brassica spp. Holm et al. (1979) list this species as a 'principal' or 'serious' weed in Egypt, Jordan, Lebanon, Italy, Turkey, Hungary, Nepal and Cuba. Severe problems in tomato have more recently been reported from Cyprus, Sudan and Chile, and from Ethiopia, where the viability of tomato juice factories have been threatened by reduced yields resulting from <i>O. ramosa</i> and <i>O. cernua</i> (Parker, 1988). Losses in yield of tobacco and tomato have been estimated at about 30%, while additional damage is caused in tobacco by effects on quality (Parker and Riches, 1993). Losses of rapeseed of 58-70% were recorded in Germany by Buschmann et al., 2005). In Ethiopia, yield losses in tomato varied from about 35% in the least susceptible varieties to 75% in the most susceptible (Mariam and Suwanketnikom, 2004). Comparable losses of about 50% in tomato yields have been calculated by Cagáň and Tóth (2003) in Slovakia. In Sudan, losses of 80-100% in tomato and potato yield have been reported (Babiker et al., 1994). In western France there has been a 'dramatic' spread of <i>O. ramosa</i> in rapeseed, tobacco and hemp (Collin, 1999; Brault et al, 2007). Infestation of tomatoes and aubergine by <i>O. ramosa</i> can be especially serious as it may prove uneconomic to continue growing these crops (and many others) for a very long period. Attempts to resume growing a susceptible crop on infested land within 5-7 years are liable to result in immediate re-infestation (Parker and Riches, 1993). Apart from the direct damage to crops, there can be further serious economic loss resulting from restrictions on the export of crop produce suspected of being infested or contaminated, as in Australia (Panetta and Lawes, 2007)."</p>

304	Environmental weed	
	Source(s)	Notes

Qsn #	Question	Answer
	Csurhes, S. & Edwards, R. 1998. Potential environmental weeds in Australia: Candidate species for preventative control. Biodiversity Group, Environment Australia, Canberra, Australia	"Host plant include various crops, legumes and grasses." [Possibly an environmental weed, but primarily a weed of agriculture]
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>O. ramosa</i> does not spread rapidly or aggressively but its introduction in contaminated seed or soil can go undetected, and once introduced it can cause severe damage to important agricultural crops and prove very difficult to eradicate." [Primarily an agricultural weed]

305	Congeneric weed	y
	Source(s)	Notes
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	" <i>O. minor</i> is a serious weed of beans and peas in Egypt; clover, rape, and tobacco in New Zealand; and legumes in Czechoslovakia. It is a principal weed of legumes in Italy, Egypt, and Australia; and grassland in Uganda and elsewhere in East Africa. It is a common weed of Lucerne in Turkey and New Zealand; legumes of several kinds in Hungary; and vegetation in Saudi Arabia."

401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>O. ramosa</i> produces leafless flowering stems, 15-20(-30) cm high, usually very branched, bearing alternate scales, less than 1 cm long. The plant is pale, completely lacking any chlorophyll. The base of the stem, below ground, is normally swollen and tuberous."

402	Allelopathic	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	[Obligate parasite requires plants to survive. No evidence of allelopathy] " <i>O. ramosa</i> is an obligate parasite, needing to establish a connection to a host root within a few days of germination. The seed is minute (approximately 0.2 x 0.4 mm), from which only the radicle emerges, and this can grow only a few millimetres long. A chemical stimulus is needed to trigger <i>Orobanche</i> germination, normally coming from host roots, therefore, <i>Orobanche</i> normally germinates only when a host root is nearby. However, a moist environment is required for several days, together with suitable temperatures, before the mature seed is responsive to germination stimulants."

Qsn #	Question	Answer
403	Parasitic	y
	Source(s)	Notes
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"O ramosa ... is a herbaceous annual or perennial root parasite without chlorophyll."
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"O. ramosa is an obligate parasite, needing to establish a connection to a host root within a few days of germination."

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"Animals could disseminate seeds if browsing infested crops, as seeds remain viable after passing through the alimentary system of animals."
	Jupp, P., Warren, P., & Secomb, N. 2002. The branched broomrape eradication program: methodologies, problems encountered and lessons learnt. Pp. 270-273 In Proceedings of the 13th Australian Weeds Conference. Plant Protection Society of Western Australia, Perth	"Over the past three years it became apparent that the presence of branched broomrape was being masked by a number of factors. The plant is palatable to stock (Jacobsohn et al. 1987) and grazing has masked the presence of the weed."

405	Toxic to animals	n
	Source(s)	Notes
	Jupp, P., Warren, P., & Secomb, N. 2002. The branched broomrape eradication program: methodologies, problems encountered and lessons learnt. Pp. 270-273 In Proceedings of the 13th Australian Weeds Conference. Plant Protection Society of Western Australia, Perth	[No evidence of toxicity] "Over the past three years it became apparent that the presence of branched broomrape was being masked by a number of factors. The plant is palatable to stock (Jacobsohn et al. 1987) and grazing has masked the presence of the weed."
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	No evidence of toxicity

Qsn #	Question	Answer
406	Host for recognized pests and pathogens	
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>O. ramosa</i> is attacked by the agromyzid fly <i>Phytomyza orobanchia</i> throughout much of its range and a high proportion of plants may be damaged as a result of larvae reducing seed production and/or mining in the stem, leading to infection by fungi and total collapse. The fly has been used for biological control and was effective in the former Soviet Union for decades. However, this biological control agent gradually became less effective due to the spread of hyperparasites that attack the <i>Phytomyza</i> pupae. See Kroschel and Klein (1999) for a detailed review of this topic. <i>Opius occuliscus</i> is the most common hyperparasite in Hungary (Horvath, 1987). Recent attempts to exploit <i>Phytomyza</i> for biocontrol of <i>O. ramosa</i> in Chile have been reported by Norambuena et al. (2001). Several plant pathogens have been reported specifically to attack <i>O. ramosa</i> (Bedi, 1994; Bozoukov and Kouzmanova, 1994), but none have yet been developed fully for biological control."

407	Causes allergies or is otherwise toxic to humans	n
	Source(s)	Notes
	Wagstaff, D.J. 2008. International poisonous plants checklist: an evidence-based reference. CRC Press, Boca Raton, FL	No evidence
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	No evidence. Not listed among negative impacts

408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	[No evidence. Any increased fire hazards would be influenced by the host plant. <i>O. ramosa</i> does not appear to increase flammability of host plants] " <i>O. ramosa</i> is an obligate parasite, needing to establish a connection to a host root within a few days of germination."

409	Is a shade tolerant plant at some stage of its life cycle	
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	[Shade tolerance irrelevant] " <i>O. ramosa</i> is an obligate parasite, needing to establish a connection to a host root within a few days of germination. The seed is minute (approximately 0.2 x 0.4 mm), from which only the radicle emerges, and this can grow only a few millimetres long. A chemical stimulus is needed to trigger <i>Orobanche</i> germination, normally coming from host roots, therefore, <i>Orobanche</i> normally germinates only when a host root is nearby. However, a moist environment is required for several days, together with suitable temperatures, before the mature seed is responsive to germination stimulants."

Qsn #	Question	Answer
410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	[Soil tolerance primarily dependent on host plant] "Most of the weedy <i>Orobanche</i> species are native to the Middle East and are adapted to soils of generally high pH. They occur to some extent in wild vegetation but the weedy species are mostly associated with the crops that they attack. <i>O. ramosa</i> requires relatively high temperatures for optimum germination and growth, and occurs mainly in irrigated crops grown under summer conditions in tropical and sub-tropical climates."
411	Climbing or smothering growth habit	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>O. ramosa</i> produces leafless flowering stems, 15-20(-30) cm high, usually very branched, bearing alternate scales, less than 1 cm long. The plant is pale, completely lacking any chlorophyll."
412	Forms dense thickets	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>O. ramosa</i> is an obligate parasite, needing to establish a connection to a host root within a few days of germination."
501	Aquatic	n
	Source(s)	Notes
	WRA Specialist. 2014. Personal Communication	Terrestrial parasitic plant
502	Grass	n
	Source(s)	Notes
	The Plant List. 2013. Version 1.1. Published on the Internet; http://www.theplantlist.org/ . [Accessed 30 May 2014]	Orobanchaceae
503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	The Plant List. 2013. Version 1.1. Published on the Internet; http://www.theplantlist.org/ . [Accessed 30 May 2014]	Orobanchaceae
504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes

Qsn #	Question	Answer
	Csurhes, S. & Edwards, R. 1998. Potential environmental weeds in Australia: Candidate species for preventative control. Biodiversity Group, Environment Australia, Canberra, Australia	" <i>Orobanche ramosa</i> is a leafless parasitic biennial or perennial with thick, fleshy roots and cream to brown stems that branch just above the ground. It stands 5-30 cm high and produces terminal spikes of pale to bright blue or violet flowers. A single plant can produce some 100,000 seeds that look like finely ground pepper and remain viable for at least nine years. <i>O. ramosa</i> must attach to the root of a host plant within a few days of germination in order to derive nutrients needed for further growth."

601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	[No evidence] "When the flowers of <i>O. ramosa</i> open, the mature anthers are already in contact with the stigma and self pollination is apparently the norm (Musselman et al.,1981). Seeds are then produced in very large numbers, many hundreds per capsule, and may remain viable in soil for many years, possibly 10 or more, and certainly for 5 years in many situations."

602	Produces viable seed	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"When the flowers of <i>O. ramosa</i> open, the mature anthers are already in contact with the stigma and self pollination is apparently the norm (Musselman et al.,1981). Seeds are then produced in very large numbers, many hundreds per capsule, and may remain viable in soil for many years, possibly 10 or more, and certainly for 5 years in many situations."

603	Hybridizes naturally	y
	Source(s)	Notes
	Cooke, D., Virtue, J., & Jupp, P. 2002. Control of branched broomrape. A literature review. Department of Water, Land and Biodiversity Conservation, Adelaide, Australia	" <i>O. aegyptiaca</i> is placed close to this clade on morphology and molecular evidence (Paran et al., 1997), and can hybridise with <i>O. ramosa</i> although it is clearly a distinct species (Katzir et al., 1996)."

604	Self-compatible or apomictic	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"When the flowers of <i>O. ramosa</i> open, the mature anthers are already in contact with the stigma and self pollination is apparently the norm (Musselman et al.,1981)."

605	Requires specialist pollinators	n
	Source(s)	Notes
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"Cross-pollination of <i>O. ramosa</i> by large Hymenoptera insects, especially bumble bees, is normal, but the plant may be selfed in the absence of insects."

Qsn #	Question	Answer
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"When the flowers of <i>O. ramosa</i> open, the mature anthers are already in contact with the stigma and self pollination is apparently the norm (Musselman et al.,1981)."
606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes
	DiTomaso, J. 2007. Weeds of California and Other Western States, Volume 2. UCANR Publications, Oakland, CA	[No evidence] "Reproduce by seed. Seeds fall near the parent plant and disperse to greater distances with wind, water, mud, soil movement, human activities, and equipment such as farm machinery. Seeds germinate in response to chemical exudates from host plant roots."
607	Minimum generative time (years)	1
	Source(s)	Notes
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	[Annual. Able to reach reproductive maturity in one growing season] "O ramosa ... is a herbaceous annual or perennial root parasite without chlorophyll."
701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"Agricultural tools and machinery can transfer <i>Orobanche</i> seeds or contaminated soil to non infested fields, thus should always be cleaned after being used in an infested field."
702	Propagules dispersed intentionally by people	n
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	" <i>Orobanche</i> species are listed as prohibited, and/or subject to quarantine, in virtually all countries with developed plant quarantine systems. See, e.g. USDA-ARS (2008) and USDA-NRCS (2008) for regulatory status in the USA." [Dispersal is generally unintentional]
703	Propagules likely to disperse as a produce contaminant	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"The risk of introduction from infested areas is high as a result of contamination of crop seed, soil or packaging materials. The minute seeds are extremely difficult to detect and have considerable longevity. Furthermore, this species can establish and propagate on a wide range of non-crop species, allowing it to build up undetected in natural vegetation before attacking host crops." ... "Hay or livestock manure may also be contaminated with viable <i>Orobanche</i> seeds if from or fed from infested areas. Agricultural products of various crops may carry <i>Orobanche</i> seeds if harvested in an infested field. "

Qsn #	Question	Answer
704	Propagules adapted to wind dispersal	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"The very small seeds may very easily be moved from one field to another by water and wind."
705	Propagules water dispersed	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"The very small seeds may very easily be moved from one field to another by water and wind."
706	Propagules bird dispersed	n
	Source(s)	Notes
	DiTomaso, J. 2007. Weeds of California and Other Western States, Volume 2. UCANR Publications, Oakland, CA	""Reproduce by seed. Seeds fall near the parent plant and disperse to greater distances with wind, water, mud, soil movement, human activities, and equipment such as farm machinery." [Seeds might adhere to birds externally, but not adapted for internal dispersal by birds]
707	Propagules dispersed by other animals (externally)	
	Source(s)	Notes
	DiTomaso, J. 2007. Weeds of California and Other Western States, Volume 2. UCANR Publications, Oakland, CA	[Possibly] ""Reproduce by seed. Seeds fall near the parent plant and disperse to greater distances with wind, water, mud, soil movement, human activities, and equipment such as farm machinery."
708	Propagules survive passage through the gut	y
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"Animals could disseminate seeds if browsing infested crops, as seeds remain viable after passing through the alimentary system of animals. "
	Cooke, D., Virtue, J., & Jupp, P. 2002. Control of branched broomrape. A literature review. Department of Water, Land and Biodiversity Conservation, Adelaide, Australia	"The indirect evidence suggests that viable seeds of <i>Orobanche ramosa</i> will not be excreted more than 6 days after ingestion by sheep, or more than 7 days by cattle. This may be confirmed by experiments using <i>O. ramosa</i> seed."
801	Prolific seed production (>1000/m²)	y
	Source(s)	Notes
	Csurhes, S. & Edwards, R. 1998. Potential environmental weeds in Australia: Candidate species for preventative control. Biodiversity Group, Environment Australia, Canberra, Australia	"A single plant can produce some 100,000 seeds that look like finely ground pepper and remain viable for at least nine years."
802	Evidence that a persistent propagule bank is formed (>1 yr)	y

Qsn #	Question	Answer
	Source(s)	Notes
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. 1997. World weeds: natural histories and distribution. John Wiley and Sons, Inc., New York, NY	"It is commonly believed that Orobanche seed persists in the fields from 1 to 12 yr, even though there is little experimental evidence to confirm the survival or viability of such seed through these years. (Bischof 1984). Seeds produced by <i>O. ramosa</i> in California during summer and fall were 10% viable. Laboratory storage survival is often stated to be 3 to 5 yr, with conditions seldom specified."
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"Seeds are then produced in very large numbers, many hundreds per capsule, and may remain viable in soil for many years, possibly 10 or more, and certainly for 5 years in many situations."

803	Well controlled by herbicides	
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"Soil fumigation with methyl bromide has been effectively used in the past, especially in light soils (Jacobsohn, 1984), but is no longer permitted. Alternatives, including metam-sodium and dazomet may provide good control but methods of use are critical and best results are normally achieved with soil coverage by plastic (see Parker and Riches, 1993). Recommended doses of these compounds are usually very high and costly but much lower doses have been reported by Chalakov (1998) to be effective in Bulgaria, perhaps resulting from a germination stimulatory effect and death by suicidal germination. Among the few herbicides to have shown adequate selective control of <i>O. ramosa</i> , imazethapyr has been reported effective in potato, but three applications are needed at 2-week intervals (Kleifeld et al., 1998). This was not safe when used on tomato. The sulfonylurea herbicides chlorsulfuron, rimsulfuron and triasulfuron have shown some selectivity against both <i>O. aegyptiaca</i> and <i>O. ramosa</i> in tomato, but application methods are critical, preferably through drip irrigation (e.g. Kleifeld et al., 1996; Vouzounis and Americanos, 1998; Goldwasser et al., 2001). Simple recommendations are not often possible but Goldwasser et al. (2001) indicate that rimsulfuron does now have approval for used on commercial crops of potato. Glyphosate at low doses post-emergence has likewise shown some selectivity in both tomato and tobacco but the margin of safety is too small for reliability. In potato, a low dose of rimsulfuron followed by 3 low-dose applications of glyphosate gave best results (Haidar et al., 2005). A range of volatile vegetable oils was also effective against <i>O. ramosa</i> in a greenhouse experiment (Solymosi, 1998). The use of transgenic crops engineered with target-site herbicide resistance is one of the most promising solutions for <i>Orobanche</i> infestation in many crops. Using glyphosate on transgenic oilseed rape, and chlorsulfuron and asulam on tobacco, complete control of <i>O. aegyptiaca</i> has been achieved without affecting the crop or its yield (Joel et al., 1995b; Nandula et al., 1999). Comparable results can be expected against <i>O. ramosa</i> ."

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

Qsn #	Question	Answer
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"Hand-weeding of emerged stems is too late to prevent crop damage but may be worthwhile where infestations are still light, to prevent or reduce future infestations. The stems should immediately be removed from the field to preclude seed shed after pulling. Unfortunately it is often difficult to see <i>O. ramosa</i> shoots under the canopy of a dense tomato crop."

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	CABI. 2014, <i>Orobanche ramosa</i> In: Invasive Species Compendium. www.cabi.org/isc	"The fly <i>Phytomyza orobanchia</i> has been used for biological control of <i>Orobanche</i> spp., including <i>O. ramosa</i> , and was effective in the former Soviet Union for decades, using special rearing and inundative release techniques. However, this became less effective due to the spread of hyperparasites. See Kroschel and Klein (1999) for a detailed review. New attempts to exploit <i>P. orobanchia</i> for biocontrol of <i>O. ramosa</i> in Chile are reported by Norambuena et al. (2001). Several <i>Fusarium</i> spp. and other plant pathogens have been reported specifically to attack <i>O. ramosa</i> (Bedi, 1994; Bozoukov and Kouzmanova, 1994), but none have yet been developed fully for biological control."

Summary of Risk Traits:

High Risk / Undesirable Traits

- Prefers temperate climates, but tolerant of tropical climates
- Broad climate suitability
- Widely naturalized
- Agricultural weed
- Other *Orobanche* species have become invasive
- Obligate parasite
- Prolific seeder
- Hybridizes with other *Orobanche* species
- Self-compatible
- Annual reproductive lifecycle
- Seeds dispersed by wind, water, machinery, & as a produce contaminant
- Forms a persistent seed bank

Low Risk Traits

- Does not spread rapidly or aggressively
- Not reported to spread vegetatively