

Taxon: *Brassica carinata* A. Braun**Family:** Brassicaceae

Common Name(s): Abyssinian cabbage
 Abyssinian mustard
 African cabbage
 Ethiopian kale
 Ethiopian mustard
 Ethiopian rape
 mustard collard

Synonym(s): *Brassica integrifolia* var. *carinata***Assessor:** Chuck Chimera**Status:** Assessor Approved**End Date:** 13 Apr 2022**WRA Score:** 6.0**Designation:** L**Rating:** Low Risk**Keywords:** Annual Herb, Cultivation Escape, Fodder, Self-Fertile, Hybrid

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		
302	Garden/amenity/disturbance weed	n=0, y = 1*multiplier (see Appendix 2)	n
303	Agricultural/forestry/horticultural weed	n=0, y = 2*multiplier (see Appendix 2)	n
304	Environmental weed	n=0, y = 2*multiplier (see Appendix 2)	n
305	Congeneric weed	n=0, y = 1*multiplier (see Appendix 2)	y
401	Produces spines, thorns or burrs	y=1, n=0	n
402	Allelopathic		
403	Parasitic	y=1, n=0	n
404	Unpalatable to grazing animals	y=1, n=-1	n
405	Toxic to animals	y=1, n=0	y

Qsn #	Question	Answer Option	Answer
406	Host for recognized pests and pathogens	y=1, n=0	y
407	Causes allergies or is otherwise toxic to humans		
408	Creates a fire hazard in natural ecosystems	y=1, n=0	n
409	Is a shade tolerant plant at some stage of its life cycle	y=1, n=0	n
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	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	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	n
706	Propagules bird dispersed	y=1, n=-1	n
707	Propagules dispersed by other animals (externally)	y=1, n=-1	n
708	Propagules survive passage through the gut	y=1, n=-1	n
801	Prolific seed production (>1000/m ²)		
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		
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
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	[Long cultivated, but evidence for selection of reduced weediness is lacking] "Brassica carinata is an amphidiploid with one genome from Brassica nigra (L.) Koch and the other from Brassica oleracea L. Ethiopia is the centre of genetic diversity of Brassica carinata, and its cultivation is thought to have started there about 4000 years BC. Truly wild types are not known, but Brassica carinata often escapes from cultivation. In the literature it has been much confused with Brassica juncea (L.) Czern., and therefore its exact distribution in Africa is difficult to indicate. The cultivation of Brassica carinata as an oil crop is restricted to Ethiopia, but as a leafy vegetable it is often grown in East and southern Africa, less so in West and Central Africa."

102	Has the species become naturalized where grown?	
	Source(s)	Notes
	WRA Specialist. (2022). Personal Communication	NA

103	Does the species have weedy races?	
	Source(s)	Notes
	WRA Specialist. (2022). 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, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 11 Apr 2022]	"Cultivated Africa NORTHEAST TROPICAL AFRICA: Eritrea, Ethiopia, Sudan EAST TROPICAL AFRICA: Kenya, Tanzania, Uganda WEST-CENTRAL TROPICAL AFRICA: Cameroon, Democratic Republic of the Congo WEST TROPICAL AFRICA: Côte D'Ivoire SOUTH TROPICAL AFRICA: Mozambique, Malawi, Zambia, Zimbabwe SOUTHERN AFRICA: Botswana WESTERN INDIAN OCEAN: Madagascar Northern America SOUTHEASTERN U.S.A.: United States [Florida] SOUTH-CENTRAL U.S.A.: United States [Texas] Naturalized Africa NORTHEAST TROPICAL AFRICA: Ethiopia"

Qsn #	Question	Answer
202	Quality of climate match data	High
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 11 Apr 2022]	

203	Broad climate suitability (environmental versatility)	y
	Source(s)	Notes
	Tropical Plants Database, Ken Fern. (2022). <i>Brassica carinata</i> . https://tropical.theferns.info/viewtropical.php?id=Brassica+carinata . [Accessed 13 Apr 2022]	" <i>Brassica carinata</i> is very tolerant of a wide range of climatic conditions and can be grown from the temperate to tropical zones. In cool temperate it is only suitable as a leaf crop, but in other areas it can also be grown for its seed. It grows best in areas where annual daytime temperatures are within the range 10 - 25°C, but can tolerate 5 - 35°C [418]. It prefers a mean annual rainfall in the range 1,000 - 1,500mm, but tolerates 800 - 1,700mm [418]."
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Ethiopian kale is rather versatile and can be found in highland regions up to 2600 m with a cool climate, but also in lowlands with relatively warm and dry conditions. It grows best in the dry season under irrigation when there are few pests and diseases. The crop is suited to a wide range of soils and especially the oil crop is often grown in marginal areas; the vegetable crop is mostly grown on more fertile soils. Ethiopian kale can grow from the equator to Canada and appears to be daylength neutral. It is sensitive to salt and seeds may not germinate in soils with an above average salinity level. Waterlogging is not tolerated."

204	Native or naturalized in regions with tropical or subtropical climates	y
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	" <i>Brassica carinata</i> is an amphidiploid with one genome from <i>Brassica nigra</i> (L.) Koch and the other from <i>Brassica oleracea</i> L. Ethiopia is the centre of genetic diversity of <i>Brassica carinata</i> , and its cultivation is thought to have started there about 4000 years BC. Truly wild types are not known, but <i>Brassica carinata</i> often escapes from cultivation. In the literature it has been much confused with <i>Brassica juncea</i> (L.) Czern., and therefore its exact distribution in Africa is difficult to indicate. The cultivation of <i>Brassica carinata</i> as an oil crop is restricted to Ethiopia, but as a leafy vegetable it is often grown in East and southern Africa, less so in West and Central Africa. "

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

Qsn #	Question	Answer
	<p>Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca. [Accessed 12 Apr 2022]</p>	<p>"3.3 Introduced range</p> <p>Africa <i>Brassica carinata</i> has been reported in Botswana, Cameroon, Côte d'Ivoire, Madagascar, Malawi, Mozambique, Sudan, Democratic Republic of the Congo, Zambia, and Zimbabwe (USDA, NRCS 2014)</p> <p>Asia <i>B. carinata</i> has been introduced to India and Pakistan (Malik 1990; Chauhan et al. 2011; Lal et al. 2013; Zada et al. 2013).</p> <p>Australia <i>B. carinata</i> has been introduced and is cultivated (Khangura and Aberra 2006).</p> <p>Europe <i>B. carinata</i> has been reported in the United Kingdom (Font et al. 2004), Greece (Namatov et al. 2000), Italy (Cardone et al. 2003; Matthäus and Angelini 2005), and Spain (Bouaid et al. 2005; Gasol et al. 2007; Martínez-Lozano et al. 2009; Alcántara et al. 2011)</p> <p>North America <i>B. carinata</i> has been cultivated in the Canada (Saskatchewan, Manitoba, Alberta) and the United States (Montana, North and South Dakota, Wyoming, Nebraska, Kansas, Oklahoma, Texas, Louisiana, Mississippi, Alabama, Georgia, Florida) (Getinet 1986; Sask Mustard 2013; NRC 2013).</p> <p>South America <i>B. carinata</i> has been grown for experimental purposes in Chile and Uruguay (NRC 2013; Seepaul et al. 2015). "</p>
	<p>Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands</p>	<p>"Production of <i>Brassica carinata</i> for its seed is important only in Ethiopia; production in Canada and the Mediterranean region is still mainly experimental. As a leafy vegetable it is mostly grown as a kitchen garden crop, although in Tanzania, Malawi, Zambia and to a lesser extent in Zimbabwe it is also grown as a market crop. Its use as a leaf crop appears to be declining because of higher yielding leaf cabbage (<i>Brassica oleracea</i>) and leaf mustard (<i>Brassica juncea</i>). "</p>

301	Naturalized beyond native range	
	Source(s)	Notes
	Hanson, C. G., & Mason, J. L. (1985). Bird seed aliens in Britain. <i>Watsonia</i> , 15(3), 237-252	" <i>Brassica carinata</i> A. Hr.: Cult. CGH; occasional" [occasional = a few plants seen most years. Not fully naturalized]
	Kull, C. A., Tassin, J., Moreau, S., Ramiarantsoa, H. R., Blanc Pamard, C., & Carrière, S. M. (2012). The introduced flora of Madagascar. <i>Biological Invasions</i> , 14(4), 875-888	"Table S1: Inventory of the introduced plants of Madagascar" [<i>Brassica carinata</i> listed as naturalized, but with no other details provided]
	USDA APHIS. (2014). Weed Risk Assessment for <i>Brassica carinata</i> A. Braun (Brassicaceae) – Ethiopian mustard. United States Department of Agriculture Animal and Plant Health Inspection Service, Raleigh, NC	"We found no evidence that <i>Brassica carinata</i> naturalizes and spreads where it has been introduced. However, this species is able to germinate and grow as a contaminant from discarded bird seed and bird-seed screenings (Clement and Foster, 1994; Hanson and Mason, 1985). It also reportedly can "often escape" from cultivation in Africa (Mnzava and Schippers, 2007). Despite decades of some breeding and cultivation in the United States, and a longer history elsewhere, relatively little biological and ecological information has been published about this species. We did not find many traits contributing to invasive potential."

Qsn #	Question	Answer
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). Germplasm Resources Information Network (GRIN-Taxonomy). National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 11 Apr 2022]	[This report of naturalization occurs within the potential region of origin of this species] "Naturalized Africa NORTHEAST TROPICAL AFRICA: Ethiopia"

302	Garden/amenity/disturbance weed	n
	Source(s)	Notes
	USDA APHIS. (2014). Weed Risk Assessment for <i>Brassica carinata</i> A. Braun (Brassicaceae) – Ethiopian mustard. United States Department of Agriculture Animal and Plant Health Inspection Service, Raleigh, NC	"In this assessment we did not find any strong evidence that <i>B. carinata</i> is likely to become a major invader or weed."
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Truly wild types are not known, but <i>Brassica carinata</i> often escapes from cultivation."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"United Kingdom-N-519, United Kingdom-U-812, United Kingdom-Z-944, Europe-N-819, Madagascar-N-1000, Slovakia-U-1484, Democratic Republic of the Congo-W-1977, Denmark-W-1977, Slovakia-W-1977." [Designation as a weed not supported by the cited references]
	Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca . [Accessed 12 Apr 2022]	[No significant negative impacts documented] "4.5 Cultivated <i>Brassica carinata</i> as a volunteer weed. Little information exists concerning seed dormancy and soil seed bank persistence of <i>Brassica carinata</i> . One previous study demonstrated that seeds exhibit some primary dormancy for a few weeks after maturation (Tokumasu et al. 1985), however it is unclear how readily seeds may enter secondary or environmentally-induced dormancy and how long they may persist in the soil. Seeds of <i>Brassica rapa</i> and <i>Brassica napus</i> can survive for several years in the soil, however their seedbanks have been observed to decline rapidly in agroecosystems (Hall 2005; USDA 2014)."

303	Agricultural/forestry/horticultural weed	n
	Source(s)	Notes
	USDA APHIS. (2014). Weed Risk Assessment for <i>Brassica carinata</i> A. Braun (Brassicaceae) – Ethiopian mustard. United States Department of Agriculture Animal and Plant Health Inspection Service, Raleigh, NC	"In this assessment we did not find any strong evidence that <i>B. carinata</i> is likely to become a major invader or weed."
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Truly wild types are not known, but <i>Brassica carinata</i> often escapes from cultivation."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

304	Environmental weed	n
	Source(s)	Notes

Qsn #	Question	Answer
	USDA APHIS. (2014). Weed Risk Assessment for <i>Brassica carinata</i> A. Braun (Brassicaceae) – Ethiopian mustard. United States Department of Agriculture Animal and Plant Health Inspection Service, Raleigh, NC	"In this assessment we did not find any strong evidence that <i>B. carinata</i> is likely to become a major invader or weed."
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	No evidence

305	Congeneric weed	y
	Source(s)	Notes
	Holm, L.G., Doll, J., Holm, E., Pancho, J.V. & Herberger, J.P. (1997). <i>World Weeds: Natural Histories and Distribution</i> . John Wiley and Sons, Inc., New York, NY	" <i>B. campestris</i> is a weed in more than 20 crops in over 50 countries (Figure: 15-1). It is a serious or principal weed of cereals in Canada, Lebanon, New Zealand, and Tasmania.; barley in Argentina, Bolivia, Colombia, Mexico, and Peru; oats in Argentina, Bolivia, and Mexico; and wheat in Argentina, Bolivia, Colombia, Guatemala, Italy, Mexico, Peru, and Uruguay. Also it is reported as a serious or principal weed of flax, linseed, and lucerne in Argentina; dry beans, maize, and sorghum in Honduras and Mexico; flax in Brazil; orchards in Honduras; pastures in Argentina, Bolivia, and the eastern United States.; peas in Argentina and New Zealand; potatoes in Honduras and Venezuela; oilseed rape and safflowers in Mexico; sugar beets in France; and vegetables in Honduras and Tasmania."
	Weber, E. (2017). <i>Invasive Plant Species of the World, 2nd Edition: A Reference Guide to Environmental Weeds</i> . CABI Publishing, Wallingford, UK	[<i>Brassica tournefortii</i>] "Spread of <i>B. tournefortii</i> in the desert areas of North America is of particular concern, because the plant suppresses native annual wildflowers over large areas (Bossard et al., 2000; Bangle et al., 2008). The plant's early growth monopolizes available soil moisture and its seeds ripen before many native species begin to flower. By 2005, about 75% of the most famous wildflower areas in California and Arizona had been colonized by Saharan mustard, aided by disturbances. Similarly, <i>B. tournefortii</i> threatens ephemeral native species in Australia (State of Queensland, 2014). The plant increases fuel loads and fire hazards in desert scrub and coastal sage scrub (Bossard et al., 2000). It establishes well after fire from the soil seed bank."

Qsn #	Question	Answer
401	Produces spines, thorns or burrs	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	[No evidence] "Erect, annual or occasionally biennial or perennial herb up to 150(–200) cm tall, usually branched, glabrous to slightly hairy at stem and petiole bases, slightly glaucous; taproot strong. Leaves alternate, usually simple, lower ones sometimes with 1 pair of small side lobes at base; stipules absent; all leaves with short petiole; blade obovate, up to 20 cm × 10 cm, double crenulate but upper ones often more or less entire. Inflorescence initially a rather loose umbel-like raceme but soon elongating, up to 50 cm long. Flowers bisexual, regular, 4-merous; pedicel ascending, 5–12 mm long; sepals oblong, 4–6(–7) mm long, green; petals obovate, 6–10 mm long, clawed, pale to bright yellow; stamens 6; ovary superior, cylindrical, 2-celled, stigma globose. Fruit a linear silique 2.5–6 cm × 2–3.5 mm, often somewhat constricted between the seeds, with a conical beak 2–6(–7) mm long, dehiscent, up to 20-seeded."

402	Allelopathic	
	Source(s)	Notes
	Rehman, S. et al. (2019). Utilizing the allelopathic potential of Brassica species for sustainable crop production: a review. Journal of Plant Growth Regulation, 38(1), 343-356	[Potentially] "Several accession of rapeseed, Indian mustard, and Ethiopian mustard (<i>Brassica carinata</i> A. Braun) suppressed the growth and biomass accumulation of different winter weeds (Sarmah et al. 1992). The suppressive effect followed an order of rapeseed > Indian mustard > Ethiopian mustard. Interestingly, the suppressive effects of these species were higher against broad-leaved weeds than narrow-leaved weeds, which might be due to selective action of responsible allelochemicals."

403	Parasitic	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Erect, annual or occasionally biennial or perennial herb up to 150(–200) cm tall, usually branched, glabrous to slightly hairy at stem and petiole bases, slightly glaucous; taproot strong." [Brassicaceae. No evidence]

404	Unpalatable to grazing animals	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"The crop is occasionally used as fodder for livestock and the seeds to feed birds. The seed cake is used as high protein food for animals, although the presence of glucosinolates is a limiting factor."

405	Toxic to animals	y
	Source(s)	Notes

Qsn #	Question	Answer
	Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca . [Accessed 12 Apr 2022]	" <i>B. carinata</i> may also be used as livestock fodder, or its meal may be used as a high protein animal feed when mixed with other protein sources." ... "Like other <i>Brassica</i> species, <i>B. carinata</i> has been investigated extensively for its ability to reduce soil-borne plant pathogens. It contains glucosinolates that produce bio-fumigants such as isothiocyanate when they breakdown."
	USDA APHIS. (2014). Weed Risk Assessment for <i>Brassica carinata</i> A. Braun (Brassicaceae) – Ethiopian mustard. United States Department of Agriculture Animal and Plant Health Inspection Service, Raleigh, NC	"Brassicaceae plants produce a group of compounds known as glucosinolates (GSLs), which, when broken down, yield isothiocyanates, nitriles, and other products (Assayed and Abd El-Aty, 2009; Halkier and Gershenzon, 2006). "Depending on the concentration and structural types of these compounds, their biological effects can be toxic, antinutritional or beneficial to health. Most serious economic problems in livestock seem to result from rapeseed meal; arising from GSLs or their breakdown products."
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"The seed cake is used as high protein food for animals, although the presence of glucosinolates is a limiting factor." [The use of glucosinolate-containing crops as primary food source for animals can have negative effects if the concentration of glucosinolate is higher than what is acceptable for the animal in question, because some glucosinolates have been shown to have toxic effects]

406	Host for recognized pests and pathogens	y
	Source(s)	Notes
	Seepaul, R. et al. (2021). <i>Brassica carinata</i> : Biology and agronomy as a biofuel crop. <i>GCB Bioenergy</i> , 13(4), 582-599	" <i>Carinata</i> is resistant to diseases that commonly affect other oilseed brassica species (Katiyar et al., 1986), including black rot caused by <i>Xanthomonas campestris</i> pv. <i>Campestris</i> (Sharma et al., 2016; Tonguc & Griffiths, 2004) and blackleg or stem canker caused by <i>Leptosphaeria maculans</i> (Gugel et al., 1990; Rimmer & Vandenberg, 1992). Disease reports include those for turnip mosaic virus (Babu et al., 2013), sclerotinia stem rot caused by <i>Sclerotinia sclerotiorum</i> (Young et al., 2012), alternaria black spot caused by <i>Alternaria alternata</i> (Dunbar et al., 2017), powdery mildew caused by <i>Erysiphe cruciferarum</i> (Gunasinghe et al., 2013), charcoal rot caused by <i>Macrophomina phaseolina</i> (Tande et al., 2015), and root rot caused by <i>Fusarium</i> species (Okello et al., 2018). Some of these pathogens are generalists, which may affect subsequent rotational crops (Okello et al., 2018). Like other brassicas, <i>carinata</i> is susceptible to insect pests, including cabbage looper <i>Trichoplusia ni</i> , diamond back moth <i>Plutella xylostella</i> , spotted cucumber beetle <i>Diabrotica undecimpunctata</i> , turnip aphid <i>Lipaphis pseudobrassicae</i> , yellow margined leaf beetle <i>Microtheca ochroloma</i> and <i>Pieris rapae</i> (Baldwin et al., 2021)."

Qsn #	Question	Answer
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Ethiopian kale is sensitive to turnip mosaic virus (TuMV) and especially the leaf crop is vulnerable. TuMV is transmitted by a range of aphids, of which the cabbage aphid <i>Brevicoryne brassicae</i> and the green peach aphid <i>Myzus persicae</i> are the most important. Oilseed types with bluish leaves have a thicker layer of leaf wax than green-leaved vegetable types and it has been noticed that leaf wax keeps aphids at bay to some extent. Leaf wax is also associated with the level of tolerance to <i>Alternaria</i> leaf spot (<i>Alternaria brassicae</i>). Ethiopian kale is susceptible to black rot (<i>Xanthomonas campestris</i>), black spot (<i>Alternaria brassicicola</i>), and to damping off and seedling root rot (<i>Rhizoctonia solani</i>). Cultivar 'Nanga' from Zambia has shown tolerance to black rot. Ethiopian kale is tolerant to black leg disease <i>Leptosphaeria maculans</i> (asexual form: <i>Phoma lingam</i>). White rust (<i>Albugo candida</i>) is mainly found on vegetable cultivars, but not in the oil crop. <i>Xanthomonas</i> , <i>Alternaria</i> , <i>Phoma</i> and <i>Rhizoctonia</i> are seedborne diseases, so a reliable seed source is most important, but these diseases are also retained in the soil so appropriate crop rotation is also essential. To avoid black rot, production during the rainy season is not recommended. The best disease control is proper management rather than a spraying regime with agro-chemicals. Diamondback moth (<i>Plutella xylostella</i>) is less problematic on Ethiopian kale than on cabbages and cauliflower. Other pests include caterpillars of the cabbage butterfly (<i>Pieris brassicae</i>) and the grubs of mustard sawfly (<i>Athalia proxima</i>), a pest that is particularly important at the seedling stage. Other pests are the cabbage and mustard aphid (<i>Hyadaphis pseudobrassicae</i> , synonym: <i>Lipaphis erysimi</i>), cabbage weevil (<i>Lixus</i> sp.), flea beetles (<i>Phyllotreta</i> spp.), and hurricane bug (<i>Bagrada cruciferarum</i>)."
	CABI. (2022). Invasive Species Compendium. Wallingford, UK: CAB International. www.cabi.org/isc	"Major host of: Beet western yellows virus (turnip (mild) yellows); <i>Galinsoga parviflora</i> (gallant soldier); <i>Phyllotreta cruciferae</i> (crucifer flea beetle) Minor host of: <i>Alternaria alternata</i> (alternaria leaf spot); <i>Erysiphe cruciferarum</i> (powdery mildew of crucifers); <i>Sclerotinia sclerotiorum</i> (cottony soft rot); Turnip mosaic virus (cabbage A virus mosaic) Host of (source - data mining): <i>Bagrada hilaris</i> (painted bug); <i>Leptosphaeria maculans</i> (stem canker); <i>Myzus persicae</i> (green peach aphid); <i>Plutella xylostella</i> (diamondback moth); <i>Xanthium strumarium</i> (common cocklebur); <i>Xanthomonas campestris</i> pv. <i>campestris</i> (black rot)"

407	Causes allergies or is otherwise toxic to humans	
	Source(s)	Notes
	Quattrocchi, U. (2012). CRC World Dictionary of Medicinal and Poisonous Plants: Common Names, Scientific Names, Eponyms, Synonyms, and Etymology. CRC Press, Boca Raton, FL	"Seed to treat stomachache; seeds oil used for rubbing on the skin." [Medicinal uses]
	Tropical Plants Database, Ken Fern. (2022). <i>Brassica carinata</i> . https://tropical.theferns.info/viewtropical.php?id=Brassica+carinata . [Accessed 13 Apr 2022]	"The oil contained in the seed of this species is rich in erucic acid which is toxic. However, modern cultivars have been selected which are almost free of erucic acid."
	WRA Specialist. (2022). Personal Communication	Toxicity may depend on cultivar

Qsn #	Question	Answer
408	Creates a fire hazard in natural ecosystems	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Truly wild types are not known, but <i>Brassica carinata</i> often escapes from cultivation." ... "Ethiopian kale is rather versatile and can be found in highland regions up to 2600 m with a cool climate, but also in lowlands with relatively warm and dry conditions. It grows best in the dry season under irrigation when there are few pests and diseases." [No evidence]

409	Is a shade tolerant plant at some stage of its life cycle	n
	Source(s)	Notes
	Plants for a Future. (2022). <i>Brassica carinata</i> . https://pfaf.org . [Accessed 13 Apr 2022]	"It can grow in semi-shade (light woodland) or no shade."
	Tropical Plants Database, Ken Fern. (2022). <i>Brassica carinata</i> . https://tropical.theferns.info/viewtropical.php?id=Brassica+carinata . [Accessed 13 Apr 2022]	"Succeeds in full sun in a well-drained fertile preferably alkaline soil"

410	Tolerates a wide range of soil conditions (or limestone conditions if not a volcanic island)	y
	Source(s)	Notes
	Tropical Plants Database, Ken Fern. (2022). <i>Brassica carinata</i> . https://tropical.theferns.info/viewtropical.php?id=Brassica+carinata . [Accessed 13 Apr 2022]	"Succeeds in any reasonable soil [52]. Prefers a pH in the range 5.5 - 8, tolerating 5 - 8.5 [418]."
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"The crop is suited to a wide range of soils and especially the oil crop is often grown in marginal areas; the vegetable crop is mostly grown on more fertile soils."

411	Climbing or smothering growth habit	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Erect, annual or occasionally biennial or perennial herb up to 150(-200) cm tall, usually branched, glabrous to slightly hairy at stem and petiole bases, slightly glaucous; taproot strong."

412	Forms dense thickets	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Truly wild types are not known, but <i>Brassica carinata</i> often escapes from cultivation." [No evidence]

Qsn #	Question	Answer
	Pua, E. C. & Douglas, C. J. (2004). <i>Brassica</i> . Springer-Verlag, Berlin Heidelberg	[No evidence. A crop with a long history of cultivation] " <i>Brassica carinata</i> (n = 17) is an amphidiploid species derived from interspecific crosses between <i>B. nigra</i> (n = 8) and <i>B. oleracea</i> (n = 9). No wild forms of <i>B. carinata</i> have been reported. Its cultivation is restricted to the Ethiopian plateau, where it might have originated from hybrids between kale, which has been grown in the plateau since ancient times, and wild or cultivated <i>B. nigra</i> . <i>Brassica carinata</i> grows slowly, a trait which it might have inherited from its <i>B. oleracea</i> parent, and its seed contains mustard oil comparable to <i>B. nigra</i> . Farmers in Ethiopia grow <i>B. carinata</i> as a leafy vegetable in their gardens and also harvest seed for oil."
	Seepaul, R. et al. (2021). <i>Brassica carinata</i> : Biology and agronomy as a biofuel crop. <i>GCB Bioenergy</i> , 13(4), 582-599	No evidence

501	Aquatic	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). <i>Plant Resources of Tropical Africa. Volume 2. Vegetables</i> . PROTA, Wageningen, Netherlands	[Terrestrial] "Ethiopian kale is rather versatile and can be found in highland regions up to 2600 m with a cool climate, but also in lowlands with relatively warm and dry conditions. It grows best in the dry season under irrigation when there are few pests and diseases. "

502	Grass	n
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). <i>Germplasm Resources Information Network (GRIN-Taxonomy)</i> . National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 11 Apr 2022]	"Family: Brassicaceae (alt. Cruciferae) Tribe: Brassiceae"

503	Nitrogen fixing woody plant	n
	Source(s)	Notes
	USDA, Agricultural Research Service, National Plant Germplasm System. (2022). <i>Germplasm Resources Information Network (GRIN-Taxonomy)</i> . National Germplasm Resources Laboratory, Beltsville, Maryland. https://npgsweb.ars-grin.gov/ . [Accessed 11 Apr 2022]	"Family: Brassicaceae (alt. Cruciferae) Tribe: Brassiceae"

504	Geophyte (herbaceous with underground storage organs -- bulbs, corms, or tubers)	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). <i>Plant Resources of Tropical Africa. Volume 2. Vegetables</i> . PROTA, Wageningen, Netherlands	"Erect, annual or occasionally biennial or perennial herb up to 150(–200) cm tall, usually branched, glabrous to slightly hairy at stem and petiole bases, slightly glaucous; taproot strong."

Qsn #	Question	Answer
601	Evidence of substantial reproductive failure in native habitat	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	" <i>Brassica carinata</i> is an amphidiploid with one genome from <i>Brassica nigra</i> (L.) Koch and the other from <i>Brassica oleracea</i> L. Ethiopia is the centre of genetic diversity of <i>Brassica carinata</i> , and its cultivation is thought to have started there about 4000 years BC. Truly wild types are not known, but <i>Brassica carinata</i> often escapes from cultivation. In the literature it has been much confused with <i>Brassica juncea</i> (L.) Czern., and therefore its exact distribution in Africa is difficult to indicate. The cultivation of <i>Brassica carinata</i> as an oil crop is restricted to Ethiopia, but as a leafy vegetable it is often grown in East and southern Africa, less so in West and Central Africa."

602	Produces viable seed	y
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Propagation is normally by seed and rarely through cuttings. The weight of 1000 seeds is 3–5 g. When grown for the leaves, sowing in a nursery and transplanting are widely practised. Seedbeds are normally raised above the soil to reduce the incidence of damping off. The top layer is dug and some well-fermented manure is worked in to produce a friable soil. Seeds are drilled in the nursery in lines 15–20 cm apart. Watering in the nursery should be done with a fine rose. Farmers may cover the seedbeds with long grass or similar material to keep the surface moist and dark. When the cotyledons have spread after germination, this mulch is removed or placed next to the plantlets."

603	Hybridizes naturally	y
	Source(s)	Notes

Qsn #	Question	Answer
	<p>Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca. [Accessed 13 Apr 2022]</p>	<p>[Artificial and natural hybrids may be possible, but rare] "<i>Brassica carinata</i> is the least studied brassicacea crop in terms of interspecific hybridization (FitzJohn et al. 2007; Cheung et al. 2015). Attempts to hybridize <i>B. carinata</i> with <i>B. maurorum</i> (Chrungu et al 1999), <i>B. tournefortii</i> (Joshi and Choudhary 1999), <i>E. lyratus</i> (Gundimeda et al. 1992), <i>E. abyssinicum</i> (Rao et al. 1996), <i>O. violaceus</i> (Li et al. 1998), <i>R. sativus</i> (Gupta 1997) and <i>S. alba</i> (Sridevi and Sarla 1996) have failed when <i>B. carinata</i> is the pollen donor (reviewed FitzJohn et al 2007). There is potential for crossing and therefore gene introgression from <i>B. carinata</i> into some of its congeners in Canada, however. The creation of hybrids of <i>B. carinata</i> with major, Canadian brassica crops (eg. <i>B. napus</i>, <i>B. juncea</i>, <i>B. rapa</i>, <i>B. oleracea</i>) have been documented in the literature. Attempts to hybridize <i>B. carinata</i> (♀) with <i>B. napus</i> (♂) have been reported seven times in the literature and have always been successful (Nagaharu 1935; Roy 1980; Wahiduzzaman 1987; Fernandez-Escobar et al. 1988; Chen and Heneen 1992; Rashid et al. 1994; Getinet et al. 1997; Pu et al. 2005; Séguin-Swartz et al. 2013; reviewed FitzJohn et al 2007). The hybridization frequency was low, with F1 hybrids being sterile (Getinet et al. 1997). Similarly, attempts to hybridize <i>B. carinata</i> (♀) with <i>B. juncea</i> (♂) have been reported eleven times and have always been successful (Nagaharu 1935; Rahman 1976; Rahman 1978; Anand et al 1985; Katiyar and Gupta 1987; Subudhi and Raut 1994; Katiyar and Chamola 1995; reviewed FitzJohn et al 2007). Attempts to hybridize <i>B. carinata</i> (♀) with <i>B. rapa</i> (♂) appears five times, succeeding 80% of the time (Howard 1942; Struss et al 1991; Meng et al 1998; Choudhary et al 2000; Rahman 2001; reviewed FitzJohn et al 2007). Hybridizations between <i>B. carinata</i> (♀) with <i>B. oleracea</i> (♂) have been reported four times, succeeding half of the time (Morinaga 1933; Nagaharu 1935; Barcikowska et al. 1983; Rahman 2001; reviewed FitzJohn et al 2007). <i>B. carinata</i> (♀) hybridization with <i>S. arvensis</i> (♂), a self-incompatible wild mustard with persistent seed banks (Warwick et al. 2000), occurs at a rate of 0.01% in the absence of pre-pollination barriers (Cheung et al. 2015). In 1109 crosses a single hybrid was produced and it generated less than 1% of the <i>B. carinata</i> (♀) parent's pollen."</p>

604	Self-compatible or apomictic	y
	Source(s)	Notes
	<p>Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands</p>	<p>"Most Brassica species are cross-pollinating, which contributes to the great diversity within species. <i>Brassica carinata</i> is an exception as it sets seed very efficiently through self-pollination without insects acting as pollinators."</p>

Qsn #	Question	Answer
605	Requires specialist pollinators	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Most Brassica species are cross-pollinating, which contributes to the great diversity within species. Brassica carinata is an exception as it sets seed very efficiently through self-pollination without insects acting as pollinators."

606	Reproduction by vegetative fragmentation	n
	Source(s)	Notes
	Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of Brassica carinata (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca . [Accessed 13 Apr 2022]	"Brassica carinata reproduces sexually, through both cross- and self-pollination, sets seed, and does not demonstrate potential for vegetative reproduction (Warwick et al. 2009; Mnzava and Schippers 2007)."
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Propagation is normally by seed and rarely through cuttings."

607	Minimum generative time (years)	1
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"The time from sowing to emergence of the seedling is about 5 days, depending on temperature and soil moisture. Plants develop an extensive root system, larger than in other Brassica species. In general, large-leaved cultivars have fewer branches than small-leaved ones. There is a difference in first flowering date between oil types and vegetable types; oil types start flowering about 10 weeks after germination, vegetable cultivars after about 12 weeks, depending on cultivar and growing conditions. Flowering of vegetable cultivars is delayed by regular harvesting of leaves or young shoots. Plants grown in dry regions flower earlier and produce ripe seeds within 4 months from sowing. Vegetable crops grown with adequate moisture produce seeds in 5–6 months."

701	Propagules likely to be dispersed unintentionally (plants growing in heavily trafficked areas)	y
	Source(s)	Notes
	Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of Brassica carinata (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca . [Accessed 13 Apr 2022]	"Environmental dispersal through human intervention occurs occasionally from transport trucks, railcars and improperly cleaned harvesters – similar to Brassica napus (Légère 2005)."

702	Propagules dispersed intentionally by people	y
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Qsn #	Question	Answer
	Source(s)	Notes
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Major Pathway/s: Contaminant, Crop, Herbal, Ornamental, Pasture Dispersed by: Humans"
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Production of <i>Brassica carinata</i> for its seed is important only in Ethiopia; production in Canada and the Mediterranean region is still mainly experimental. As a leafy vegetable it is mostly grown as a kitchen garden crop, although in Tanzania, Malawi, Zambia and to a lesser extent in Zimbabwe it is also grown as a market crop. Its use as a leaf crop appears to be declining because of higher yielding leaf cabbage (<i>Brassica oleracea</i>) and leaf mustard (<i>Brassica juncea</i>)."
	WRA Specialist. (2022). Personal Communication	Sold in commercial seed mixes

703	Propagules likely to disperse as a produce contaminant	y
	Source(s)	Notes
	Hanson, C. G. (2019). Birdseed aliens originating from Niger (<i>Guizotia abyssinica</i>) wild bird food. <i>British & Irish Botany</i> , 1(4), 292-308	"Although batches of Niger (<i>Guizotia abyssinica</i>) seed imported for wild bird food from North Africa, and more recently India, achieve a very high degree of purity, impurities occur and include some taxa potentially capable of growing to maturity in Britain and Ireland. Many such plants are important arable weeds in regions where <i>G. abyssinica</i> is grown on a large scale for human consumption. This paper lists species that have been cultivated over the last ten years from commercially available Niger seed, and the years of their occurrence." [Brassica carinata is a seed contaminant in bird seed]
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Major Pathway/s: Contaminant, Crop, Herbal, Ornamental, Pasture Dispersed by: Humans"

704	Propagules adapted to wind dispersal	n
	Source(s)	Notes
	Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca . [Accessed 13 Apr 2022]	" <i>B. carinata</i> seed does not possess wing or feather-like structures, so wind-mediated dispersal is expected to be negligible. "

705	Propagules water dispersed	n
	Source(s)	Notes
	Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca . [Accessed 13 Apr 2022]	"Furthermore, <i>B. carinata</i> seed does not possess wing or feather-like structures, so wind-mediated dispersal is expected to be negligible. Similar observations have been made with regard to water movement of <i>B. carinata</i> seed; only 5.5% and 0.2% of seeds float in non-turbulent and turbulent water respectively (E. Johnson, unpublished)."

706	Propagules bird dispersed	n
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Qsn #	Question	Answer
	Source(s)	Notes
	Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca . [Accessed 13 Apr 2022]	"While <i>B. carinata</i> dispersal through animal intervention has been proposed to occur through bird feeding, observed feeding rates have been reported to be low (Zanetti et al. 2013)."

707	Propagules dispersed by other animals (externally)	n
	Source(s)	Notes
	Grubben, G.J.H. & Denton, O.A. (ed.). (2004). Plant Resources of Tropical Africa. Volume 2. Vegetables. PROTA, Wageningen, Netherlands	"Fruit a linear siliqua 2.5–6 cm × 2–3.5 mm, often somewhat constricted between the seeds, with a conical beak 2–6(–7) mm long, dehiscent, up to 20-seeded. Seeds globose, 1–1.5 mm in diameter, finely reticulated, pale to dark brown." [No evidence. No means of external attachment]
	Randall, R.P. (2017). A Global Compendium of Weeds. 3rd Edition. Perth, Western Australia. R.P. Randall	"Major Pathway/s: Contaminant, Crop, Herbal, Ornamental, Pasture Dispersed by: Humans"

708	Propagules survive passage through the gut	n
	Source(s)	Notes
	Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca . [Accessed 13 Apr 2022]	"While <i>B. carinata</i> dispersal through animal intervention has been proposed to occur through bird feeding, observed feeding rates have been reported to be low (Zanetti et al. 2013)."

Qsn #	Question	Answer
801	Prolific seed production (>1000/m ²)	
	Source(s)	Notes
	<p>USDA APHIS. (2014). Weed Risk Assessment for <i>Brassica carinata</i> A. Braun (Brassicaceae) – Ethiopian mustard. United States Department of Agriculture Animal and Plant Health Inspection Service, Raleigh, NC</p>	<p>[Potentially in cultivation, but unknown from natural settings] "We found no information on seed production in natural populations, but there was some information on agronomic yield. In a study of plant traits under agronomic conditions, plants produced an average of 270 pods (range = 179 to 352) and 3300 seeds (range = 1900 to 5200) per plant (Alemayehu and Becker, 2002). Assuming at least two plants per square meter and 98 percent seed viability (Séguin-Swartz et al., 2013), two plants alone would be sufficient to meet the threshold of 5000 seeds per square meter. In another study, seed yield was 597 and 1267 kg/ha in 1984 and 1985, respectively (Getinet et al., 1996), with thousand-seed weights ranging from 3.7 g to 4.6 g in 1984 and from 4.9 g to 5.7 g in 1985 (Getinet et al., 1996). Using the heaviest estimates of seed weight, this yield converts to 13,000 and 22,000 seeds per square meter. Other studies reported similar thousand-seed weights: 3.48 g (Alemayehu and Becker, 2002) and 2.0 to 3.9 g (Warwick et al., 2006). Therefore, under field production where water, herbicides, and fertilizers may be used to maximize yield, <i>B. carinata</i> is a prolific reproducer. However, because there is no information about seed production outside of cultivation, we answered unknown."</p>

802	Evidence that a persistent propagule bank is formed (>1 yr)	
	Source(s)	Notes
	<p>Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca. [Accessed 13 Apr 2022]</p>	<p>"Little information exists concerning seed dormancy and soil seed bank persistence of <i>Brassica carinata</i>. One previous study demonstrated that seeds exhibit some primary dormancy for a few weeks after maturation (Tokumasu et al. 1985), however it is unclear how readily seeds may enter secondary or environmentally-induced dormancy and how long they may persist in the soil. Seeds of <i>Brassica rapa</i> and <i>Brassica napus</i> can survive for several years in the soil, however their seedbanks have been observed to decline rapidly in agroecosystems (Hall 2005; USDA 2014)."</p>

803	Well controlled by herbicides	y
	Source(s)	Notes
	<p>Plant and Biotechnology Risk Assessment Unit. (2017). The Biology of <i>Brassica carinata</i> (A.) Braun (Abyssinian cabbage). Biology Document BIO2017-02. Plant Health Science Division, Canadian Food Inspection Agency. Ottawa, Ontario. https://inspection.canada.ca. [Accessed 13 Apr 2022]</p>	<p>"<i>Brassica carinata</i> can be controlled with 2,4-D, or any broadleaf herbicide registered to control wild mustard or volunteer canola. No glyphosate-tolerant <i>B. carinata</i> varieties have been developed to date. However, there may be some level of tolerance to dicamba (Johnson et al. 2014) and dinotroaniline herbicides (soil applied) including trifluralin (Johnson et al. 2014)."</p>

Qsn #	Question	Answer
804	Tolerates, or benefits from, mutilation, cultivation, or fire	
	Source(s)	Notes
	WRA Specialist. (2022). Personal Communication	Unclear. More often cultivated, rather than controlled

805	Effective natural enemies present locally (e.g. introduced biocontrol agents)	
	Source(s)	Notes
	WRA Specialist. (2022). Personal Communication	Unknown

Summary of Risk Traits:

High Risk / Undesirable Traits

- Broad climate suitability
- Thrives and spreads in regions with tropical climates
- Possibly naturalized outside native range (unconfirmed)
- Common cultivation escape
- Other Brassica species are invasive weeds
- May be allelopathic
- Contains glucosinolates that can be toxic to livestock
- Host of other crop pests and pathogens
- Tolerates many soil types
- Reproduces by seeds
- Hybridizes with other Brassica species (but rarely under natural conditions)
- Self-fertile
- Quickly reaches maturity
- Seeds dispersed intentionally through cultivation and unintentionally through activities related to cultivation (equipment, bird seed contaminant, possible crop contaminant)
- Prolific seed production under cultivation

Low Risk Traits

- Valued as a palatable pasture species, with no verified negative impacts reported
- Unarmed (no spines, thorns, or burrs)
- Palatable (despite potential toxicity)
- Grows best in high light environments (dense shade may inhibit spread)
- Herbicides may provide effective control if needed

Second Screening Results for Herbs or Low Stature Shrubby Life Forms

(A) Reported as a weed of cultivated lands? No

(B) Unpalatable to grazers or known to form dense stands? No. Palatable and not known to form dense stands.

Outcome = Accept (Low Risk)

