



United States Department of Agriculture

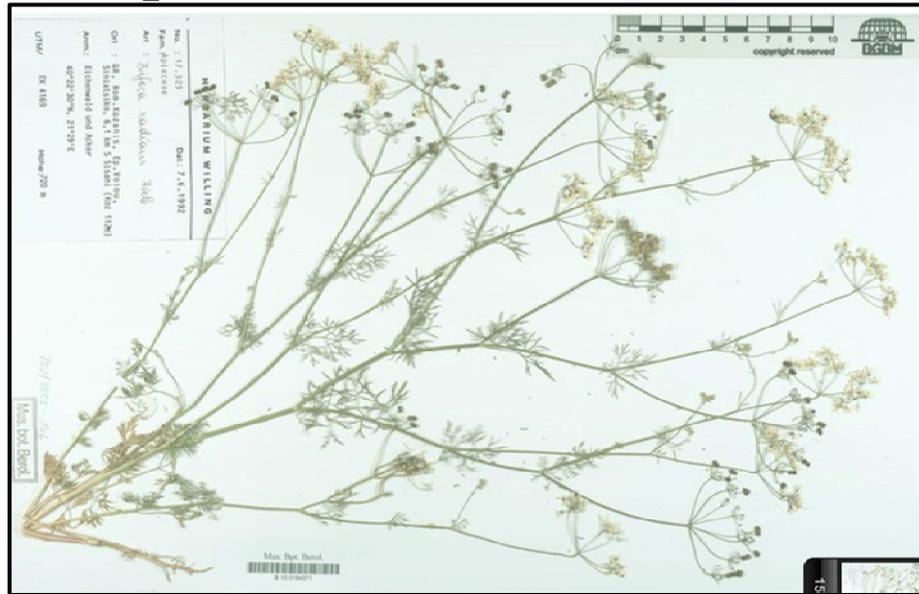
United States
Department of
Agriculture

Animal and Plant
Health Inspection
Service

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Version 1

Weed Risk Assessment for *Bifora radians* M. Bieb (Apiaceae) – Wild bishop



Herbarium image of *Bifora radians* (source: Botanischer Garten und Botanisches Museum Berlin-Dahlem; Röpert, 2000+ [continuously updated]).

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Introduction Plant Protection and Quarantine (PPQ) regulates noxious weeds under the authority of the Plant Protection Act (7 U.S.C. § 7701-7786, 2000) and the Federal Seed Act (7 U.S.C. § 1581-1610, 1939). A noxious weed is defined as “any plant or plant product that can directly or indirectly injure or cause damage to crops (including nursery stock or plant products), livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment” (7 U.S.C. § 7701-7786, 2000). We use the PPQ weed risk assessment (WRA) process (PPQ, 2015) to evaluate the risk potential of plants, including those newly detected in the United States, those proposed for import, and those emerging as weeds elsewhere in the world.

The PPQ WRA process includes three analytical components that together describe the risk profile of a plant species (risk potential, uncertainty, and geographic potential; PPQ, 2015). At the core of the process is the predictive risk model that evaluates the baseline invasive/weed potential of a plant species using information related to its ability to establish, spread, and cause harm in natural, anthropogenic, and production systems (Koop et al., 2012). Because the predictive model is geographically and climatically neutral, it can be used to evaluate the risk of any plant species for the entire United States or for any area within it. We then use a stochastic simulation to evaluate how much the uncertainty associated with the risk analysis affects the outcomes from the predictive model. The simulation essentially evaluates what other risk scores might result if any answers in the predictive model might change. Finally, we use Geographic Information System (GIS) overlays to evaluate those areas of the United States that may be suitable for the establishment of the species. For a detailed description of the PPQ WRA process, please refer to the *PPQ Weed Risk Assessment Guidelines* (PPQ, 2015), which is available upon request.

We emphasize that our WRA process is designed to estimate the baseline—or unmitigated—risk associated with a plant species. We use evidence from anywhere in the world and in any type of system (production, anthropogenic, or natural) for the assessment, which makes our process a very broad evaluation. This is appropriate for the types of actions considered by our agency (e.g., Federal regulation). Furthermore, risk assessment and risk management are distinctly different phases of pest risk analysis (e.g., IPPC, 2015). Although we may use evidence about existing or proposed control programs in the assessment, the ease or difficulty of control has no bearing on the risk potential for a species. That information could be considered during the risk management (decision making) process, which is not addressed in this document.

***Bifora radians* M. Bieb. – Wild bishop**

Species Family: Apiaceae

Information Synonyms: *Anidrum radians* (M. Bieb.) Kuntze, and *Coriandrum radians* (M. Bieb.) Prantl (The Plant List, 2016).

Common names: Wild bishop (AgroAtlas, 2016).

Botanical description: *Bifora radians* is an erect annual plant that grows 15 to 40 cm tall (Hanf, 1983). Leaves are 2 to 3 pinnately compound and produce an offensive odor when crushed (Hanf, 1983). Inflorescences are a compound umbel, where secondary umbels contain 7-9 flowers that are either bisexual or male (AgroAtlas, 2016). For a full botanical description of this species and genus see AgroAtlas, 2016; Bojňanský and Fargašová, 2007; Britton, 1907.

Initiation: PPQ received market access requests for corn and wheat grain for human and animal consumption from the government of Ukraine (Government of Ukraine, 2013a, 2013b). Commodity import risk analyses determined that *B. radians* may be potentially associated with both of these commodities as a contaminant. In this assessment, we evaluated the risk potential of this species to the United States to help policy makers determine whether it should be regulated as a Federal Noxious Weed.

Foreign distribution and status: *Bifora radians* is native to western Asia (Iran, Turkey), the Caucasus (Armenia, Azerbaijan, Georgia, Dagestan), and Europe (Albania, Bosnia, Bulgaria, Croatia, France, Greece, Herzegovina, Italy, Macedonia, Montenegro, Romania, Serbia, Slovenia, Spain, and Ukraine) (GBIF, 2016; NGRP, 2016). It is naturalized elsewhere (NGRP, 2016), including in Britain, the Czech Republic, and Sweden (Clement and Foster, 1994; DAISIE, 2016; Pyšek et al., 2002). It is not clear if it is native (NGRP, 2016) or exotic (DAISIE, 2016) to Germany. It is reported as a casual alien for Belgium (Verloove, 2006). It is common and widespread in southern Europe, where it often occurs abundantly in cereal crops (Hanf, 1983).

U.S. distribution and status: This species has been reported for the United States in one to two counties each in Pennsylvania, New Jersey, and Rhode Island (Anonymous, 2016; Britton, 1907; Kartesz, 2016). Records for Pennsylvania and Rhode Island are probably based on an old report by Britton (1907); however, a New England botany group reports that the species is present in Rhode Island (Anonymous, 2016). In New Jersey, *B. radians* is reported from ballast from old ports, but it is probably not naturalized there (Weakley, 2015). We did not find any additional or modern accounts of this species from the United States, which raises doubts as to whether it is really naturalized in the United States. We found no evidence that this species is cultivated in the United States (e.g., Bailey and Bailey, 1976; Brenzel, 1995; Cullen et al., 2011; Dave's Garden,

warm summers, humid continental cool summers, and subarctic. We had high uncertainty as to whether this species could survive in Plant Hardiness Zone 5 because it is reported as a thermophilic species (AgroAtlas, 2016; Bojňanský and Fargašová, 2007); however, we believe it could survive there based on a distribution map provided in AgroAtlas (2016).

The area of the United States shown to be climatically suitable (Fig. 1) is likely overestimated since our analysis considered only three climatic variables. Other environmental variables, such as soil and habitat type, may further limit the areas in which this species is likely to establish. This species occurs in fields, embankments, vineyards, roadsides, waste places, meadows, waste places, ballast heaps, and arable land (Anonymous, 2016; Bojňanský and Fargašová, 2007; Britton, 1907; Skorda et al., 1998). In central Europe where the summer climate is less hot, it is restricted to cultivated, calcareous soils (Hanf, 1983). Elsewhere it is reported to prefer nitrogen-containing alkaline soils (AgroAtlas, 2016).

Entry Potential It is not entirely clear if *B. radians* is currently present in the United States (see discussion under U.S. status). As such, we assumed it is not present, and evaluated its entry potential. Because this species is not cultivated, it did not obtain a very high risk score for this risk element, which ranges from 0 to 1. This species may be introduced to the United States intentionally because it is used in local cooking (AgroAtlas, 2016) or it may be useful in coriander breeding programs (Diederichsen, 1996). It may also enter the United States unintentionally as a grain or seed contaminant (Clement and Foster, 1994; Dunn, 1905; Stace, 2010; Verloove, 2006). There is one report that it may also move in trade as a contaminant in wool (Verloove, 2006).
Risk score = 0.30 Uncertainty index = 0.14

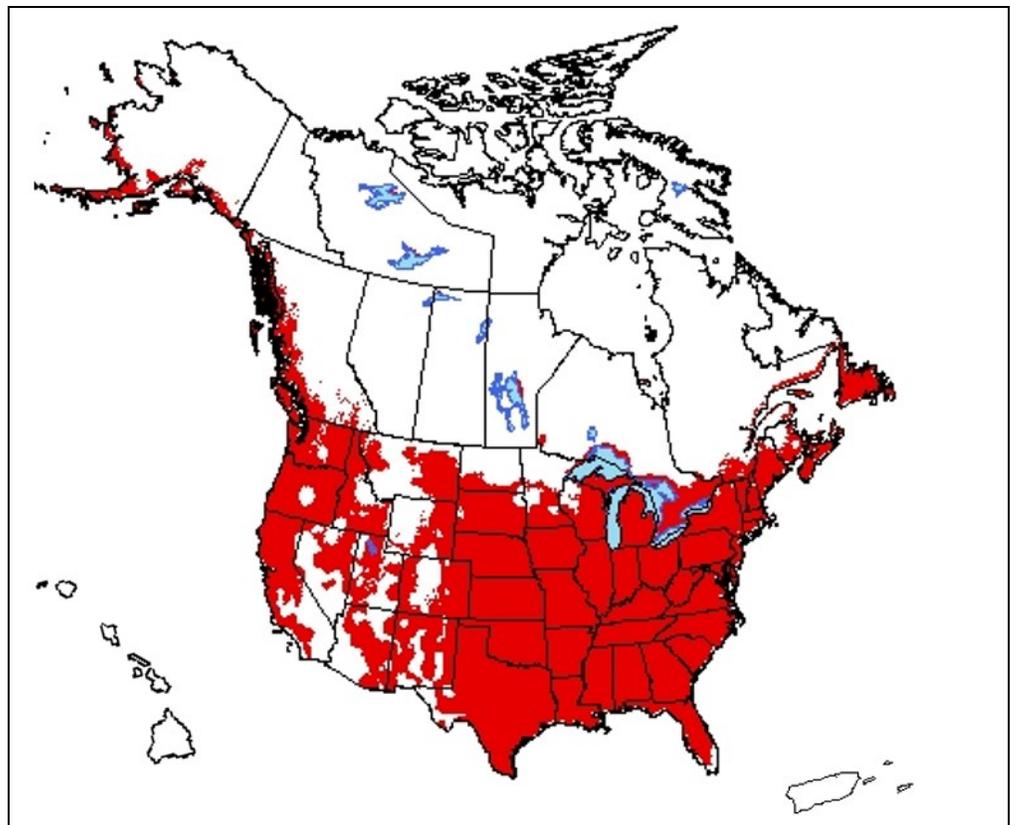


Figure 1. Predicted distribution of *Bifora radians* in the United States and Canada. Map insets for Hawaii and Puerto Rico are not to scale.

2. Results

Model Probabilities: P(Major Invader) = 62.0%
P(Minor Invader) = 36.2%
P(Non-Invader) = 1.8%

Risk Result = High Risk

Secondary Screening = Not Applicable

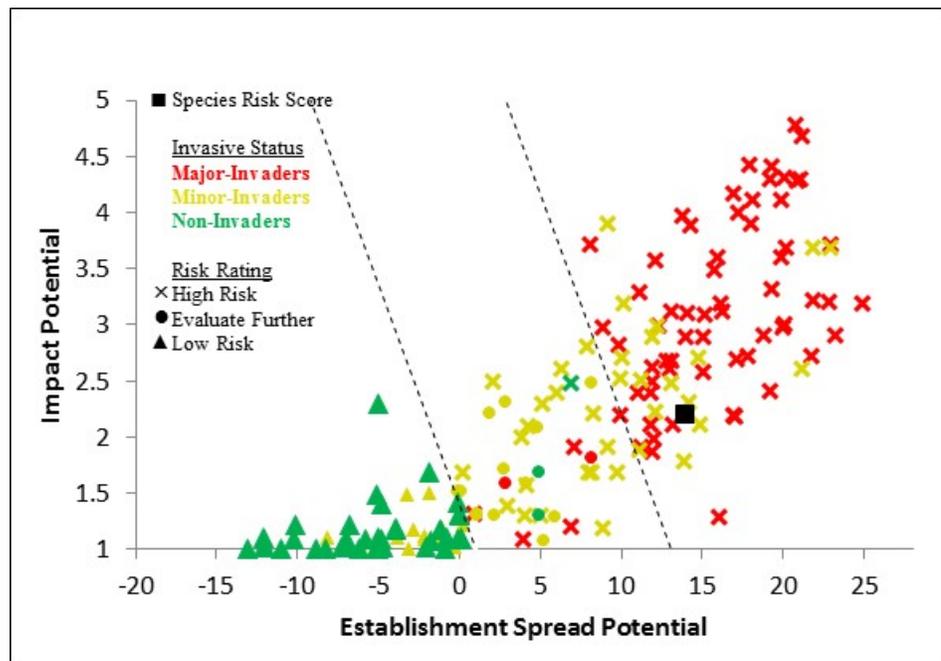


Figure 2. *Bifora radians* risk score (black box) relative to the risk scores of species used to develop and validate the PPQ WRA model (other symbols). See Appendix A for the complete assessment.

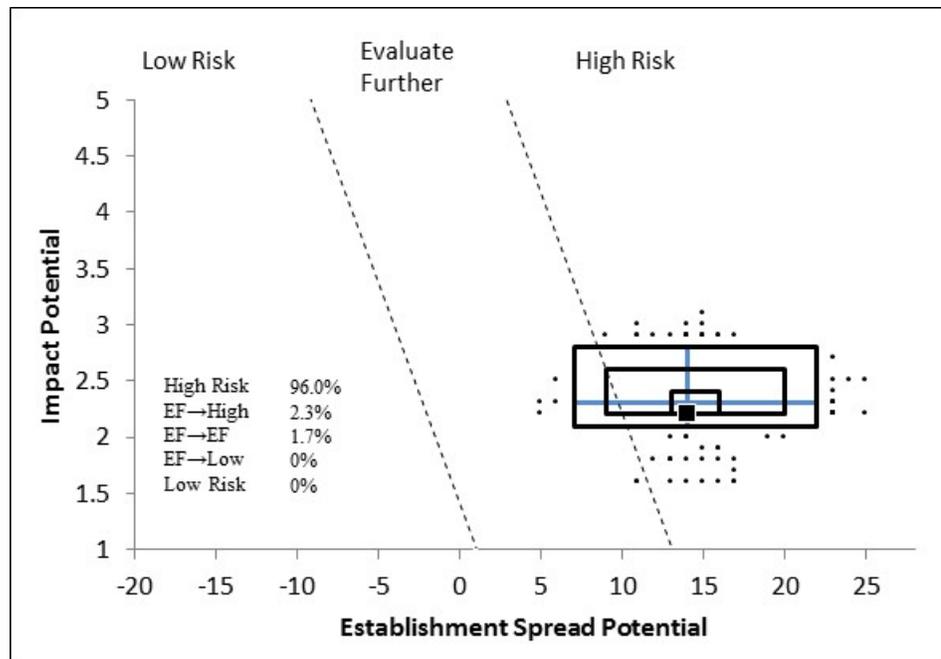


Figure 3. Model simulation results (N=5,000) for uncertainty around the risk score for *B. radians*. The blue “+” symbol represents the medians of the simulated outcomes. The smallest box contains 50 percent of the outcomes, the second 95 percent, and the largest 99 percent.

3. Discussion

The result of the weed risk assessment for *B. radians* is High Risk (Fig. 2), which is supported by the results of our uncertainty analysis (Fig. 3). Relative to its establishment/spread risk score, *B. radians* has a relatively low impact risk score (Fig. 2). This is consistent with our findings that it is generally a minor agricultural weed, except in some crops, such as wheat, where it reduces yield (Mennan and Zandstra, 2005; Uygur and Mennan, 1995) and taints the cereal (AgroAtlas, 2016; Hanf, 1983). *Bifora radians* has been associated with wheat since the Middle Ages (Borojević, 2005). Although most populations of this species respond to herbicides, control is challenging because of extended emergence times (end of winter to end of spring) (Skorda et al., 1998). Continuous wheat cropping favors the buildup of populations of *B. radians* (Skorda et al., 1998).

Our review found that populations of *B. radians* are behaving differently in different parts of its native range. On one hand, some authors report that it is declining and rare in crops, and that chemical weeding may even threaten the species (Diederichsen, 1996; Lonchamp, 2000). On the other hand, it is reported to be a serious problem in Greece and Turkey, where it appears to be increasing in abundance and distribution (Mennan and Işık, 2003; Mennan and Zandstra, 2005; Skorda et al., 1998). Skorda et al. (1998) speculate that in Greece increased wheat cropping and the use of reduced tillage techniques is favoring populations of *B. radians*, particularly since herbicides are not very effective for a species with an extended emergence time. In Turkey, the species may be becoming more frequent and problematic because populations resistant to herbicides have evolved (Heap, 2016; Mennan et al., 2012).

Wheat is an economically important crop for the United States, and *B. radians* poses a potential risk to U.S. winter wheat production. This species was introduced to the United States over a hundred years ago (Britton, 1907) and does not appear to have spread from where it was originally found in the northeast (Kartesz, 2016; Weakley, 2015), if it is even still present. If introduced to the central and western United States, this species may behave differently since that climate is drier and more similar to that of the southern and western Mediterranean than that of the eastern United States. A large portion of the country's winter wheat production is centered on western Kansas and southwestern Washington (USDA-NASS, 2015), areas which are climatically suitable for this species (Fig. 1).

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Appendix A. Weed risk assessment for *Bifora radians* M. Bieb (Apiaceae). Below is all of the evidence and associated references used to evaluate the risk potential of this taxon. We also include the answer, uncertainty rating, and score for each question. The Excel file, where this assessment was conducted, is available upon request.

Question ID	Answer - Uncertainty	Score	Notes (and references)
ESTABLISHMENT/SPREAD POTENTIAL			
ES-1 [What is the taxon's establishment and spread status outside its native range? (a) Introduced elsewhere =>75 years ago but not escaped; (b) Introduced <75 years ago but not escaped; (c) Never moved beyond its native range; (d) Escaped/Casual; (e) Naturalized; (f) Invasive; (?) Unknown]	e - high	2	<i>Bifora radians</i> is native to western Asia (Iran, Turkey), the Caucasus (Armenia, Azerbaijan, Georgia, Dagestan), and Europe (Albania, Bosnia, Bulgaria, Croatia, France, Greece, Herzegovina, Italy, Macedonia, Montenegro, Romania, Serbia, Slovenia, Spain, and Ukraine) (GBIF, 2016; NGRP, 2016). It is naturalized elsewhere in Europe (NGRP, 2016), including in Britain, the Czech Republic, and Sweden (Clement and Foster, 1994; DAISIE, 2016; Pyšek et al., 2002; Rauschert, 1961). It is not clear if it is native (NGRP, 2016) or exotic (DAISIE, 2016) to Germany. It is reported as a casual alien for Belgium (Verloove, 2006). "Although previously of little agronomic importance, since the late 1970's it has become a prominent weed in winter cereals in northern Greece and to lesser extent in some central parts of the country with a high percentage of winter cereals and it is increasing in intensity and geographic spread" (Skorda et al., 1998). This species has also been becoming more prevalent in Turkey (Mennan and Işık, 2003; Mennan and Zandstra, 2005). We answered "e" because this species is naturalized outside of its native range. Reports of it becoming more frequent and spreading in its native range do not support an "f" because this question focuses on a species status in its introduced range. Furthermore, reports of it "spreading" in its native range may simply reflect its increasing abundance. Alternate answers for the uncertainty simulation were "f" and "d."
ES-2 (Is the species highly domesticated)	n - low	0	<i>Bifora radians</i> is used as a spicy herb in dishes, and its leaves are used in salads (AgroAtlas, 2016). However, we found no evidence that it is cultivated or even domesticated. Plant breeders have tried crossing this species with coriander, but have not had much luck (Diederichsen, 1996).
ES-3 (Weedy congeners)	y - low	1	There are three species in the genus <i>Bifora</i> (Mabberley, 2008). Of these, <i>B. radians</i> and <i>B. testiculata</i> have been reported as weeds (Randall, 2012). <i>Bifora testiculata</i> is classified as a noxious weed in Australia (Parsons and Cuthbertson, 2001).
ES-4 (Shade tolerant at some stage of its life cycle)	n - mod	0	We found no evidence that <i>B. radians</i> is shade tolerant.
ES-5 (Plant a vine or scrambling plant, or forms tightly appressed basal rosettes)	n - negl	0	This plant is an erect, annual herb (Hanf, 1983).
ES-6 (Forms dense thickets, patches, or populations)	y - low	2	In agricultural fields in northern Greece it reaches densities ranging from 10 to 48 plants per square meter (Skorda et al., 1998).
ES-7 (Aquatic)	n - negl	0	This species is a terrestrial herb (AgroAtlas, 2016).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-8 (Grass)	n - negl	0	This species is not a grass; rather, it is an herb in the family Apiaceae (NGRP, 2016).
ES-9 (Nitrogen-fixing woody plant)	n - negl	0	This species is not a woody plant (AgroAtlas, 2016). Furthermore, it is not in a plant family known to contain nitrogen-fixing bacteria (Martin and Dowd, 1990; Santi et al., 2013).
ES-10 (Does it produce viable seeds or spores)	y - negl	1	<i>Bifora radians</i> produces viable seeds (Mennan, 2003; Skorda et al., 1998).
ES-11 (Self-compatible or apomictic)	? - max	0	Unknown.
ES-12 (Requires specialist pollinators)	? - max		Unknown.
ES-13 [What is the taxon's minimum generation time? (a) less than a year with multiple generations per year; (b) 1 year, usually annuals; (c) 2 or 3 years; (d) more than 3 years; or (?) unknown]	b - negl	1	This species is an annual (Bojňanský and Fargašová, 2007; Hanf, 1983; Stace, 2010) that germinates in the spring, flowers June to August, and bears fruit by August (AgroAtlas, 2016). We found no evidence that it produces two or more generations per year; consequently, we answered "b" with negligible uncertainty. Alternate answers for the uncertainty simulation were both "c."
ES-14 (Prolific seed producer)	y - high	1	Seed production varies from 110 to 500 seeds per plant in wheat, and plants reach densities of 10 to 48 plants per square meter (Skorda et al., 1998). Thus plants may be producing from 1,110 to 24,000 seeds per square meter. A seed burial experiment showed that this species exhibits cyclical dormancy and that the maximum percentage of germinating seeds at any one point was about 40 percent (Mennan, 2003). In that same study, a tetrazolium test of seed viability showed that freshly collected seeds start out with about 90 percent viability. Although this data indicates that the species is biologically capable of prolific reproduction (more than 5,000 viable seeds per square meter), it is not clear whether this threshold is met in the field. Because the larger portion of this range (999 to 19,440 viable seeds per square meter) exceeds 5,000, we answered yes, but with high uncertainty.
ES-15 (Propagules likely to be dispersed unintentionally by people)	y - low	1	Agricultural machinery re-introduces this species to fields where it has been eliminated (Skorda et al., 1998).
ES-16 (Propagules likely to disperse in trade as contaminants or hitchhikers)	y - negl	2	Introduced to Britain as a grain alien (Dunn, 1905). Sometimes found as a grain alien (Clement and Foster, 1994; Stace, 2010). Listed as a grain/wool alien in Belgium (Verloove, 2006). Contaminant of wheat seed in Turkey (Mennan and Işik, 2003). Samples of <i>Secale cereale</i> (rye) seed from traditional agricultural areas in Albania contain contaminants of <i>B. radians</i> (Gladis et al., 2009). The congener <i>B. testiculata</i> is a contaminant of grain in Australia (GTA, No Date).
ES-17 (Number of natural dispersal vectors)	1	-2	Propagule traits for questions ES-17a through ES-17e: Fruit is globose, didymous (occurring in pairs), and about 3 mm x 6 mm in size (Hanf, 1983). Seeds are pale yellow and about 2 by 2.5 mm in size (AgroAtlas, 2016).
ES-17a (Wind dispersal)	n - negl		We found no evidence that this species is wind dispersed. Furthermore, neither the fruit nor the seed have any classic adaptations for wind dispersal (e.g., wings, plumes, etc.).

Question ID	Answer - Uncertainty	Score	Notes (and references)
ES-17b (Water dispersal)	n - mod		We found no evidence that this species is water dispersed or that its seeds are buoyant.
ES-17c (Bird dispersal)	n - mod		We found no evidence that it is bird dispersed.
ES-17d (Animal external dispersal)	y - high		This species is reported as a wool alien for Belgium (Verloove, 2006), suggesting that seeds may get caught in animal fur. However, because we found only this one piece of evidence, and because the fruit are round and lack any obvious adaptations for attaching to animals, we used high uncertainty.
ES-17e (Animal internal dispersal)	? - max		Unknown.
ES-18 (Evidence that a persistent (>1yr) propagule bank (seed bank) is formed)	y - negl	1	In one thorough field study, Mennan (2003) buried seeds of <i>B. radians</i> at four different depths and later exhumed them every month for several years to examine viability. He found that seeds can remain dormant under field conditions for several years and that they exhibit peaks in germinability after an initial period of primary dormancy. Also, seeds buried more deeply had higher viability rates than those at or close to the soil surface (Mennan, 2003). In another study, buried seeds germinated for 19 months (Skorda et al., 1998).
ES-19 (Tolerates/benefits from mutilation, cultivation or fire)	? - max	0	Unknown.
ES-20 (Is resistant to some herbicides or has the potential to become resistant)	y - negl	1	Populations of <i>B. radians</i> have developed resistance to acetolactate synthase (ALS)-inhibiting herbicides in Turkey (Heap, 2016). A field experiment comparing the effect of various doses of herbicides on susceptible and resistant populations demonstrated that the recommended application rates of herbicides were not sufficient to kill populations of the weeds (Mennan et al., 2012).
ES-21 (Number of cold hardiness zones suitable for its survival)	6	0	
ES-22 (Number of climate types suitable for its survival)	7	2	
ES-23 (Number of precipitation bands suitable for its survival)	10	1	
IMPACT POTENTIAL			
General Impacts			
Imp-G1 (Allelopathic)	n - mod	0	Other than one author <i>speculating</i> that it may have allelopathic effects on other plant species (Mennan et al., 2012), we found no evidence that this species is allelopathic.
Imp-G2 (Parasitic)	n - negl	0	We found no evidence. This species is not a member of a plant family known to contain parasitic plants (Heide-Jorgensen, 2008; Nickrent, 2009).
Impacts to Natural Systems			
Imp-N1 (Changes ecosystem processes and parameters that affect other species)	n - low	0	We found no evidence that this species is a weed of natural areas or that it invades natural areas outside of its native range. Consequently, we used low uncertainty for all of the questions in this sub-element.
Imp-N2 (Changes habitat structure)	n - low	0	We found no evidence of <i>B. radians</i> having this impact.
Imp-N3 (Changes species diversity)	n - low	0	We found no evidence of <i>B. radians</i> having this impact.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Imp-N4 (Is it likely to affect federal Threatened and Endangered species?)	n - low	0	We found no evidence indicating that this is a likely impact.
Imp-N5 (Is it likely to affect any globally outstanding ecoregions?)	n - low	0	We found no evidence indicating that this is a likely impact.
Imp-N6 [What is the taxon's weed status in natural systems? (a) Taxon not a weed; (b) taxon a weed but no evidence of control; (c) taxon a weed and evidence of control efforts]	a - low	0	We found no evidence that it is a weed of or present in natural systems. Alternate answers for the uncertainty simulation were both "b."
Impact to Anthropogenic Systems (e.g., cities, suburbs, roadways)			
Imp-A1 (Negatively impacts personal property, human safety, or public infrastructure)	n - low	0	We found no evidence. Because this impact seems unlikely for a short-statured annual herb, we used low uncertainty.
Imp-A2 (Changes or limits recreational use of an area)	n - low	0	We found no evidence. Because this impact seems unlikely for a short-statured annual herb, we used low uncertainty.
Imp-A3 (Affects desirable and ornamental plants, and vegetation)	n - mod	0	We found no evidence of <i>B. radians</i> having this impact.
Imp-A4 [What is the taxon's weed status in anthropogenic systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	a - mod	0	This species occurs in human-mediated habitats (Pyšek et al., 2002) in roadsides, waste places, and ballast heaps (Britton, 1907; Skorda et al., 1998); however, we found no evidence that it is considered a weed in these types of areas. Alternate answers for the uncertainty simulation were both "b."
Impact to Production Systems (agriculture, nurseries, forest plantations, orchards, etc.)			
Imp-P1 (Reduces crop/product yield)	y - negl	0.4	<i>Bifora radians</i> is a competitive winter annual weed of crops in Turkey, the Mediterranean, and the Caucasus Sea region (Mennan et al., 2012). Its aggressive growth habit and allegedly allelopathic effects allow the species to compete strongly with wheat and other crops (Mennan et al., 2012). This species is problematic in winter cereals, particularly in wheat because it reduces yield (Uygur and Mennan, 1995). In one experimental study in Turkey, <i>B. radians</i> reduced wheat yield by 12–40 percent, depending on weed and crop densities (Mennan and Zandstra, 2005). Considering the cost of herbicides, plant densities of 1.8–4.7 were determined to represent an economic threshold for economically significant impacts (Uygur and Mennan, 1995).
Imp-P2 (Lowers commodity value)	y - negl	0.2	It causes lodging in wheat under high weed densities (Skorda et al., 1998). "Known as a 'cereal tainter' because the crop absorbs the smell of the weed" (Hanf, 1983). Seeds are difficult to separate from coriander and spoil the crop because <i>B. radians</i> seeds taint the flavor of the essential oil obtained from coriander (AgroAtlas, 2016).
Imp-P3 (Is it likely to impact trade?)	n - mod	0	This species has been reported as a contaminant of grain and seed by several sources (see evidence under ES-16); however, we found no evidence that it is regulated by a foreign country (e.g., APHIS, 2016).
Imp-P4 (Reduces the quality or availability of irrigation, or	n - mod	0	We found no evidence.

Question ID	Answer - Uncertainty	Score	Notes (and references)
strongly competes with plants for water)			
Imp-P5 (Toxic to animals, including livestock/range animals and poultry)	n - low	0	We found no evidence that this species or the genus is toxic to animals (e.g., Burrows and Tyrl, 2013; Nelson et al., 2007).
Imp-P6 [What is the taxon's weed status in production systems? (a) Taxon not a weed; (b) Taxon a weed but no evidence of control; (c) Taxon a weed and evidence of control efforts]	c - negl	0.6	<i>Bifora radians</i> is an agricultural weed, particularly of winter (cereal) crops (Hanf, 1983), coriander (AgroAtlas, 2016), and onions (Mennan and Işik, 2003). It is reported as a weed across a broad region from Europe through the Caucasus region of Asia (AgroAtlas, 2016; Cakovic et al., 2012; Nestorovic and Konstantinovic, 2011; Williams, 1982). It is considered a minor agricultural weed of southern and central Europe (Williams, 1982), but a serious one in the Caucasus region (AgroAtlas, 2016). The availability of studies investigating control options and the availability of recommended control strategies (AgroAtlas, 2016; Bakos et al., 1991; Markovic et al., 2005; Mennan et al., 2012; Mennan and Zandstra, 2005; Rauschert, 1961) supports the idea that that it is a significant weed in at least some regions. "Acetolactate synthase (ALS) - inhibiting herbicides and mixtures are registered in wheat to control <i>B. radians</i> " (Mennan et al., 2012). Because herbicides are not controlling this species as effectively as they once did, researchers are now trying to identify wheat cultivars that are naturally more competitive with <i>B. radians</i> for use in an integrated pest management system (Mennan and Zandstra, 2005). Alternate answers for the uncertainty simulation were both "b."
GEOGRAPHIC POTENTIAL			Unless otherwise indicated, the following evidence represents geographically referenced points obtained from the Global Biodiversity Information Facility (GBIF, 2016).
Plant hardiness zones			
Geo-Z1 (Zone 1)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z2 (Zone 2)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z3 (Zone 3)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z4 (Zone 4)	n - mod	N/A	One point in Austria. Because this is only one point and because this species has been reported to be thermophilic (AgroAtlas, 2016; Bojňanský and Fargašová, 2007), we answered no.
Geo-Z5 (Zone 5)	y - high	N/A	One point each in Austria (GBIF, 2016), Turkey (GBIF, 2016), and Belarus (AgroAtlas, 2016). A regional map for the Caucasus indicates it is in this zone (AgroAtlas, 2016). However, because this species is thermophilic (AgroAtlas, 2016; Bojňanský and Fargašová, 2007), we used high uncertainty.
Geo-Z6 (Zone 6)	y - negl	N/A	Germany and Austria. Regional distribution in the Caucasus (AgroAtlas, 2016).
Geo-Z7 (Zone 7)	y - negl	N/A	France, Germany, and Spain.
Geo-Z8 (Zone 8)	y - negl	N/A	Belgium, France, and Germany.
Geo-Z9 (Zone 9)	y - negl	N/A	France and Spain. One point each in the Netherlands and the United Kingdom.
Geo-Z10 (Zone 10)	y - low	N/A	A few points along the coast in France and Spain. One point in Turkey. Regional distribution in the Caucasus (AgroAtlas, 2016).

Question ID	Answer - Uncertainty	Score	Notes (and references)
Geo-Z11 (Zone 11)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z12 (Zone 12)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Geo-Z13 (Zone 13)	n - negl	N/A	We found no evidence that it occurs in this hardiness zone.
Köppen -Geiger climate classes			
Geo-C1 (Tropical rainforest)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C2 (Tropical savanna)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C3 (Steppe)	y - negl	N/A	Spain. Regional distribution in the Caucasus (AgroAtlas, 2016).
Geo-C4 (Desert)	n - low	N/A	We found no evidence that it occurs in this climate class; however, it occurs near this class in Armenia (AgroAtlas, 2016).
Geo-C5 (Mediterranean)	y - low	N/A	A few points in Greece. Two points in Turkey (Mennan et al., 2012; Mennan and Zandstra, 2005).
Geo-C6 (Humid subtropical)	y - negl	N/A	One to two points each in Bulgaria, Greece, and Ukraine. Regional occurrence in Samsun Turkey (Mennan et al., 2012; Mennan and Zandstra, 2005), and the Caucasus region (AgroAtlas, 2016).
Geo-C7 (Marine west coast)	y - negl	N/A	Belgium, France, and Germany.
Geo-C8 (Humid cont. warm sum.)	y - low	N/A	One point in Georgia. Regional distribution in the Caucasus (AgroAtlas, 2016).
Geo-C9 (Humid cont. cool sum.)	y - negl	N/A	Austria, Germany, and Sweden.
Geo-C10 (Subarctic)	y - high	N/A	Some points in France, Germany, and Spain.
Geo-C11 (Tundra)	n - negl	N/A	We found no evidence that it occurs in this climate class.
Geo-C12 (Icecap)	n - negl	N/A	We found no evidence that it occurs in this climate class.
10-inch precipitation bands			
Geo-R1 (0-10 inches; 0-25 cm)	n - high	N/A	We found no evidence that it occurs in this precipitation band.
Geo-R2 (10-20 inches; 25-51 cm)	y - negl	N/A	Spain. One point each in Turkey and Ukraine.
Geo-R3 (20-30 inches; 51-76 cm)	y - negl	N/A	France and Spain. A few points in Greece and Turkey.
Geo-R4 (30-40 inches; 76-102 cm)	y - negl	N/A	France. A few points in Greece.
Geo-R5 (40-50 inches; 102-127 cm)	y - negl	N/A	France, Germany, and Greece.
Geo-R6 (50-60 inches; 127-152 cm)	y - negl	N/A	France and Germany.
Geo-R7 (60-70 inches; 152-178 cm)	y - low	N/A	A few points in Austria and Germany.
Geo-R8 (70-80 inches; 178-203 cm)	y - low	N/A	A few points in Austria and Germany.
Geo-R9 (80-90 inches; 203-229 cm)	y - low	N/A	A few points in Austria and Germany.
Geo-R10 (90-100 inches; 229-254 cm)	y - high	N/A	Regional distribution in the Caucasus (AgroAtlas, 2016).
Geo-R11 (100+ inches; 254+ cm)	y - high	N/A	Regional distribution in the Caucasus (AgroAtlas, 2016).
ENTRY POTENTIAL			
Ent-1 (Plant already here)	n - high	0	This species has been reported for the United States in one to two counties each in Pennsylvania, New Jersey, and Rhode Island (Anonymous, 2016; Britton, 1907; Kartesz, 2016), but it is not entirely clear if it currently present (see discussion under U.S. status). As such, we assumed it is not present, and evaluated its entry potential.

Question ID	Answer - Uncertainty	Score	Notes (and references)
Ent-2 (Plant proposed for entry, or entry is imminent)	n - mod	0	We found no evidence that its entry is imminent.
Ent-3 (Human value & cultivation/trade status)	b - high	0.05	The plant is used as a spicy herb in many dishes, and its leaves are used to prepare a savory salad (AgroAtlas, 2016). A variety of research has been conducted evaluating the composition and potential impact of extracts of the plant on other species (Islamoglu and Koçak, 2014; Koroğlu et al., 2012; Özkirim et al., 2012). Plant breeders have tried crossing this species with coriander, but have not had much luck (Diederichsen, 1996). Because this species is used locally (if not cultivated) and because it is of interest to some breeder of coriander, we answered "b" with high uncertainty.
Ent-4 (Entry as a contaminant)			
Ent-4a (Plant present in Canada, Mexico, Central America, the Caribbean or China)	n - low		We found no evidence this species is present in these countries (e.g., Brouillet et al., 2015; eFloras, 2016; Villaseñor Ríos and Espinosa García, 1998).
Ent-4b (Contaminant of plant propagative material (except seeds))	n - mod	0	We found no evidence of <i>B. radians</i> contaminating these products.
Ent-4c (Contaminant of seeds for planting)	y - low	0.04	Contaminant of wheat seed in Turkey (Mennan and Işık, 2003). Samples of <i>Secale cereale</i> seed from traditional agricultural areas in Albania contain <i>B. radians</i> as a contaminant (Gladis et al., 2009).
Ent-4d (Contaminant of ballast water)	y - low	0.03	Reported from waste places and ballast sites in Rhode Island, Pennsylvania, and New Jersey (Britton, 1907; Weakley, 2015).
Ent-4e (Contaminant of aquarium plants or other aquarium products)	n - mod	0	We found no evidence of <i>B. radians</i> contaminating these products.
Ent-4f (Contaminant of landscape products)	n - mod	0	We found no evidence of <i>B. radians</i> contaminating these products.
Ent-4g (Contaminant of containers, packing materials, trade goods, equipment or conveyances)	n - mod	0	We found no evidence of <i>B. radians</i> contaminating these products.
Ent-4h (Contaminants of fruit, vegetables, or other products for consumption or processing)	y - negl	0.01	Is sometimes found as a grain alien in the United Kingdom (Clement and Foster, 1994; Dunn, 1905; Stace, 2010). Listed as a grain alien in Belgium (Verloove, 2006). Contaminant of wheat seed in Turkey (Mennan and Işık, 2003). The congener <i>B. testiculata</i> is a contaminant of grain in Australia (GTA, No Date).
Ent-4i (Contaminant of some other pathway)	b - high	0.01	This species is reported as a wool alien for Belgium (Verloove, 2006), suggesting that seeds may get caught in animal fur. However, because we found only this one piece of evidence, and because the fruit are round and lack any obvious adaptations for attaching to animals, we used high uncertainty.
Ent-5 (Likely to enter through natural dispersal)	n - low	0	Because this species is not present in a region near the United States and because it does not have any specialized long-distance dispersal methods (see evidence provided under ES-17), we answered no with low uncertainty.