# Risk analysis for plants as pests for *Ambrosia trifida*

COSAVE

STDF Standards and Trade Development Facility

IICA

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# RISK ANALYSIS FOR PLANTS AS PESTS FOR *Ambrosia trifida* L. (Asteraceae)


*Ambrosia trifida*
Image: Theodore Webster, USDA Agricultural Research Service

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# 1. STAGE I: INITIATION

## 1.1. INITIATION POINT FOR THE PEST RISK ANALYSIS

*Ambrosia trifida* was identified as a species which could be unintentionally introduced to the COSAVE region, as a contaminant of grains or other imported products. It is an important crop weed in North America and Europe, as well as being an important cause of allergies.

## 1.2. IDENTITY OF THE PLANT

**Accepted scientific name:**

*Ambrosia trifida* L. (The Plant List, 2013)

**Synonyms:**

*Ambrosia aptera DC*, *Ambrosia integrifolia* Muhl. ex Willd. (The Plant List, 2013).

**Common names:**

In English: giant ragweed (official name according to the Weed Science Society of America), buffalo-weed, horseweed (Germplasm Resources Information Network, 2018), great ragweed (USDA-NRCS, 2018), Texan great ragweed, tall ragweed, blood ragweed, perennial ragweed (Integrated Taxonomic Information System, 2018).

In Spanish: artemisa grande (EPPO, 2018a), although no examples were found of the use of this name in the literature, and it is sometimes applied to *Artemisia tridentata* Nutt.

No Portuguese common name for *A. trifida* was found.

**Taxonomic position:**

Family Asteraceae

Subfamily Asteroideae

Tribe Heliantheae

(Funk et al., 2009).

*Ambrosia trifida* was described by Linnaeus in 1753 (IPNI, 2018). It is a well-defined species that presents no taxonomic or identification problems (Strother, 2006).

## 1.3. IDENTIFICATION OF THE PEST RISK ANALYSIS AREA

For the purpose of this case study, the PRA area will be considered as the entire COSAVE region.

## 1.4. PEST RISK ANALYSIS HISTORY

No previous pest risk analysis (PRA) performed by any COSAVE member country was found.

In Australia *A. trifida* was identified as a species that could be introduced as a contaminant of maize imported from the USA. (Weed Technical Working Group, 1999). A PRA of *Ambrosia artemisiifolia, Ambrosia psilostachya* and *Ambrosia trifida* for Poland concluded that these species warranted classification as quarantine pests (Karnkowski, 2001). However, they do not appear in the current list of species regulated by Poland (EPPO, 2018b). Mekky et al. (2010 ) analyzed the risk of introduction of *Ambrosia trifida, Ambrosia artemisiifolia* and other weeds in Egypt by the pathway of contamination of imported grains.

## 1.5. CONCLUSION OF STAGE I

A pest risk analysis was carried out for *A. trifida* for the COSAVE region as a whole, in response to the risk of its unintentional introduction.

# 2. STAGE II. WEED RISK ASSESSMENT

## 2.1. CATEGORIZATION

### 2.1.1. PRESENCE OR ABSENCE OF THE PLANT IN THE PEST RISK ANALYSIS AREA

No records of *A. trifida* were found for the COSAVE region in GBIF (Global Biodiversity Information Facility, 2018), Flora of Argentina (Zuloaga, 2006), Flora of Brazil (Flora do Brasil, 2020 em construção), or in the database of non-native plants in Chile (Fuentes et al., 2013). It was concluded that *A. trifida* is absent from the COSAVE region.

### 2.1.2. REGULATORY STATUS

#### 2.1.2.1. In the pest risk analysis area

*Ambrosia trifida* does not appear in the List of Principal Regulated Pests for the COSAVE Region (COSAVE, 2016). In Peru it is classified as a quarantine pest not present (SENASA-PERÚ, 2017). *Ambrosia trifida* appears on the list of regulated pests for Argentina as a quarantine pest, not present (IPPC, 2017).

#### 2.1.2.2. Worldwide

*Ambrosia trifida* appears on the A1 lists (absent quarantine pests) of Kazakhstan, Uzbekistan, Azerbaijan, and Ukraine; in the A2 lists (quarantine pests not widely distributed) of Moldova and Russia; and is a quarantine pest in Belarus. It also appears in the EPPO list of Invasive Alien Plants (EPPO, 2018a); EPPO strongly recommends that its member countries take measures to prevent the introduction and spread of the species mentioned in this list.

In South Africa *A. trifida* is a prohibited alien species under the National Environmental Management: Biodiversity Act (Department of Environmental Affairs, 2014).

In Canada, *A. trifida* seed is classified as "Class 2 primary noxious " under the Federal Seed Act, which limits the amount of weed seeds allowed in seeds offered for sale or imported into Canada (Canadian Food Inspection Agency, 2017).

In the U.S.A. *A. trifida* is classified as a state noxious weed by the states of California, Delaware and Illinois (USDA-NRCS, 2018).

In Egypt the importation of grains contaminated with seeds of *A. trifida, A. psilostachya* and *A. artemisiifolia* is prohibited, according to (Mekky et al., 2010 ). However, these species do not appear in the current list of pests regulated by Egypt, which in fact does not include any weed species (IPPC, 2014).

### 2.1.3. POTENTIAL FOR ESTABLISHMENT AND SPREAD IN THE PRA AREA

There are potentially suitable environmental and climatic conditions for *A. trifida* in parts of the territory of all COSAVE member countries (see 2.3.2).

### 2.1.4. POTENTIAL FOR ECONOMIC OR ENVIRONMENTAL IMPACT

*Ambrosia trifida* is a weed of great economic importance in corn, soybeans, wheat, cotton, and other crops in North America and China, and to a lesser extent in Europe. Its effects on human health due to the production of allergies also have a considerable economic impact (see 2.3.3.3).

### 2.1.5. CONCLUSION OF CATEGORIZATION

Based on the information gathered for the previous sections, it was concluded that *A. trifida* meets the requirements to be considered as a quarantine pest, being absent from the PRA area and with potential to cause economic or environmental impacts on plants in the PRA area.

## 2.2. INFORMATION ABOUT THE PLANT

### 2.2.1. GEOGRAPHIC DISTRIBUTION OF THE PLANT

**Native distribution:**

Canada: Alberta, Manitoba, New Brunswick, Nova Scotia, Ontario, Prince Edward Island, Quebec, Saskatchewan (USDA-NRCS, 2018).

USA: Alabama, Arizona, Arkansas, California, North Carolina, South Carolina, Colorado, Connecticut, North Dakota, South Dakota, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Iowa , Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, New Mexico, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Utah, Vermont, Virginia, West Virginia, Washington, Wisconsin, Wyoming (USDA-NRCS, 2018).

Mexico: Chihuahua, Coahuila, Sonora, Baja California Sur (Germplasm Resources Information Network, 2018; Global Biodiversity Information Facility, 2018)

**Naturalized distribution:**

Asia: Georgia, China, Japan (Germplasm Resources Information Network, 2018); Korea (Kim et al., 2004). In China it is reported from the provinces of Hebei, Heilongjiang, Hunan, Jiangxi, Jilin, Liaoning, Shandong, Sichuan, and Zhejiang (Flora of China Editorial Committee, 2011).

Europe: Lithuania, Germany, the Netherlands, Slovakia, Denmark, United Kingdom, Italy, France, Spain (Germplasm Resources Information Network, 2018); Austria, Slovenia, Switzerland, Czech Republic, Serbia (Follak et al., 2013).

In addition to the countries mentioned where *A. trifida* is naturalized, there are casual records or records of unknown status of *A. trifida* in Israel, Belarus, Denmark, Estonia, Finland, Latvia, Moldova, Norway, Russia (European part), Sweden, Ukraine, Belgium, Poland, Ireland, and Slovenia (DAISIE, 2018; Germplasm Resources Information Network, 2018).

**Cultivated distribution:**

*Ambrosia trifida* is not cultivated.

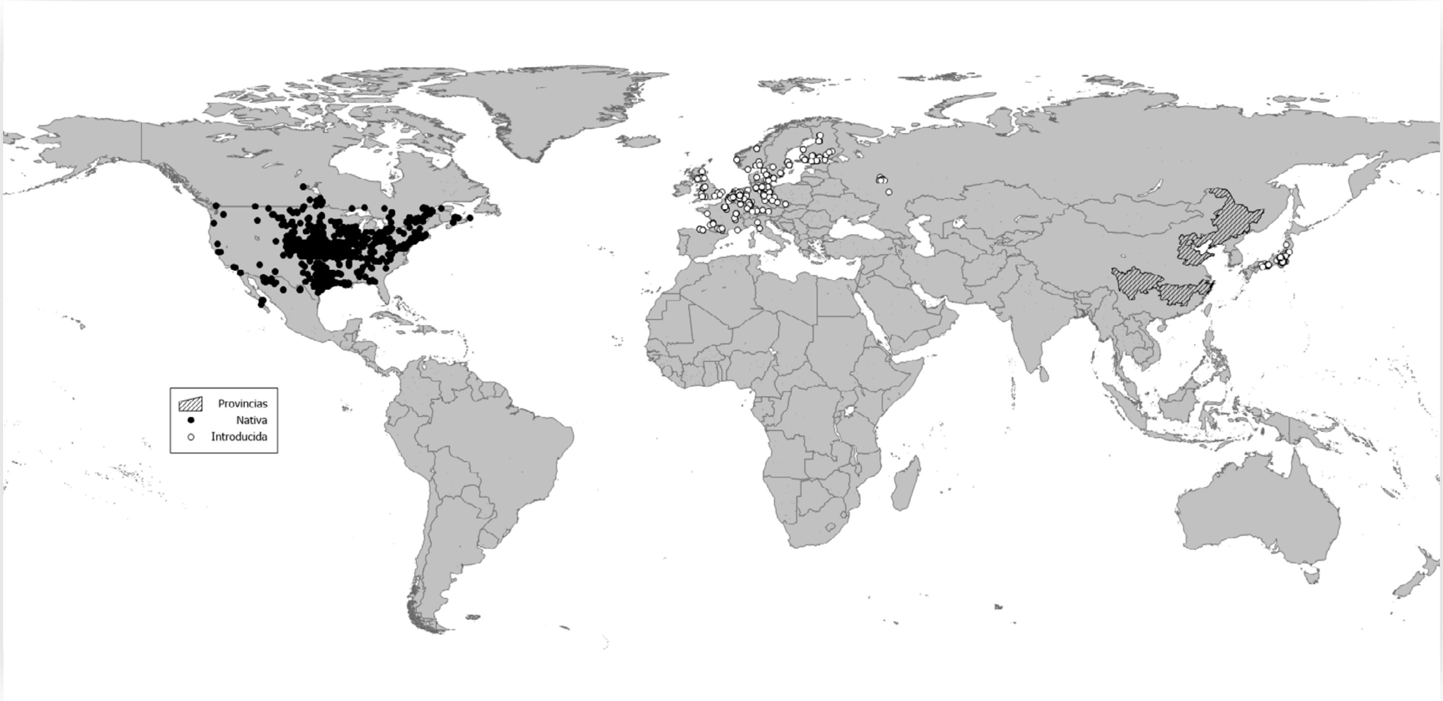


**Figure 1.** Worldwide distribution of *Ambrosia trifida* (Global Biodiversity Information Facility, 2018); provinces of China with records of *A. trifida* according to Flora of China Editorial Committee (2011).

## 2.2.2. BIOLOGY OF THE PLANT

### 2.2.2.1. Morphology

*Ambrosia trifida* is a herb with branched, erect stems 30 - 150 cm in height (sometimes up to 400 cm). Leaves mostly opposite, slightly scabrous, rounded-deltate to ovate or elliptical, 40-150 × 30-70 mm, some palmate with 3 (-5) lobes, margins usually dentate, petioles 10-30 mm. Flowers green, monoecious, inflorescence in the form of a spike. The fruit is a pyramidal achene 3-5 mm in length, with 4 to 5 straight spines of 0.5-1 mm, containing a single seed (Strother, 2006).

### 2.2.2.2. Life cycle

Ambrosia trifida is annual and blooms from July to November in the northern hemisphere. Pollination is by wind (anemophilous). It reproduces only by seed. The flowers are capable of self-pollination, but the progeny from this are less vigorous than those resulting from crossing. A typical A. trifida plant in Illinois produces about 275 seeds (Bassett and Crompton, 1982), although a production of 1,650 seeds per plant is also cited (Stevens, 1932). The mature seeds survive the winter persisting in the inflorescences or in the soil.

In Illinois (USA) the seeds of A. trifida are among the first species to germinate in the spring, at the beginning of March. In Quebec (Canada) the time of maximum germination is from the end of April to the beginning of May. In the U.S.A. some populations of A. trifida show multiple flushes of germination throughout the growing season (Michigan State University, 2018). Seeds germinate best at alternating temperatures of 20°C - 30°C, after a cold period (stratification), and covered by a minimum of 2 cm of soil (Bassett and Crompton, 1982).

The viability of freshly collected seeds in Ohio (USA) varied between 48% and 53%. In a period of 4 years, the percentage of viable seeds dropped to zero for the seeds on the surface of the soil and 19% when they were buried at a depth of 20 cm; however, some seeds buried at 20 cm can retain their viability at least 9 years in the soil (Harrison et al., 2007).

#### 2.2.2.3. Dispersal

The seeds of *A. trifida* have no specific adaptations for dispersal. The seeds do not float well, indicating that dispersal by water is not very important (Parker and Leck, 1985). However, seeds of *A. trifida* were found in very small amounts among leaf litter deposited on marine beaches and along the River Rhine in the Netherlands (Cappers, 1993).

In Ohio (USA) the European earthworm *Lumbricus terrestris* collects the seeds of *A. trifida* and buries them in its burrows at a depth of up to 22 cm, removing a large amount of the seed that falls on the soil surface. This protects the seed from other predators and may contribute to the formation of the seed bank (Regnier et al., 2008).

#### 2.2.2.4. Habitat and environmental factors affecting the plant

*Ambrosia trifida* is a plant of alluvial plains, and predominates in disturbed, moist soils along irrigation canals and streams (Bassett and Crompton, 1982). Strother, (2006 ) indicates its habitat as disturbed sites and vacant lots with wet soils. In New Jersey (USA) it was abundant on the banks of channels in a freshwater tidal wetland (Parker and Leck, 1985).

In central and eastern Europe it is mainly a species of ruderal habitats (such as industrial and urban areas, and railroad edges), and is found less frequently in riparian zones or cultivated fields (Follak et al., 2013). In South Korea it was abundant in a disused landfill near Seoul (Kim et al., 2004) and in a riverbank area (Lee et al., 2010). In Japan it is present in farms, orchards, paddocks, riverbanks, roadsides, and vacant lots (National Research and Development Agency, 2018) and was found invading a nature reserve (Miyawaki and Washitani, 1996, cited in Follak et al. al., 2013).

*Ambrosia trifida* has no specific requirements as to the type of soil (CABI, 2016) but according to the University of Michigan (2018) prefers fertile soils with high levels of nitrogen, phosphorus and potassium

#### 2.2.2.5. Climatic Adaptation

The great majority of records of *A. trifida* with geographical coordinates in GBIF occur in climatic zones Dfb (snow climate, fully humid, warm summer), Dfa (continental without dry season, warm summer, cold winter) [not present in the COSAVE region], Cfa (warm temperate, fully humid, hot summer), Cfb (warm temperate, fully humid, warm summer) and BSk (cold steppe) according to the modified Köppen and Geiger system (see Annex 1), with a few localities in zones Csb, Csa, Dfc, BSh, BWh, and Dwa (Figure 2).

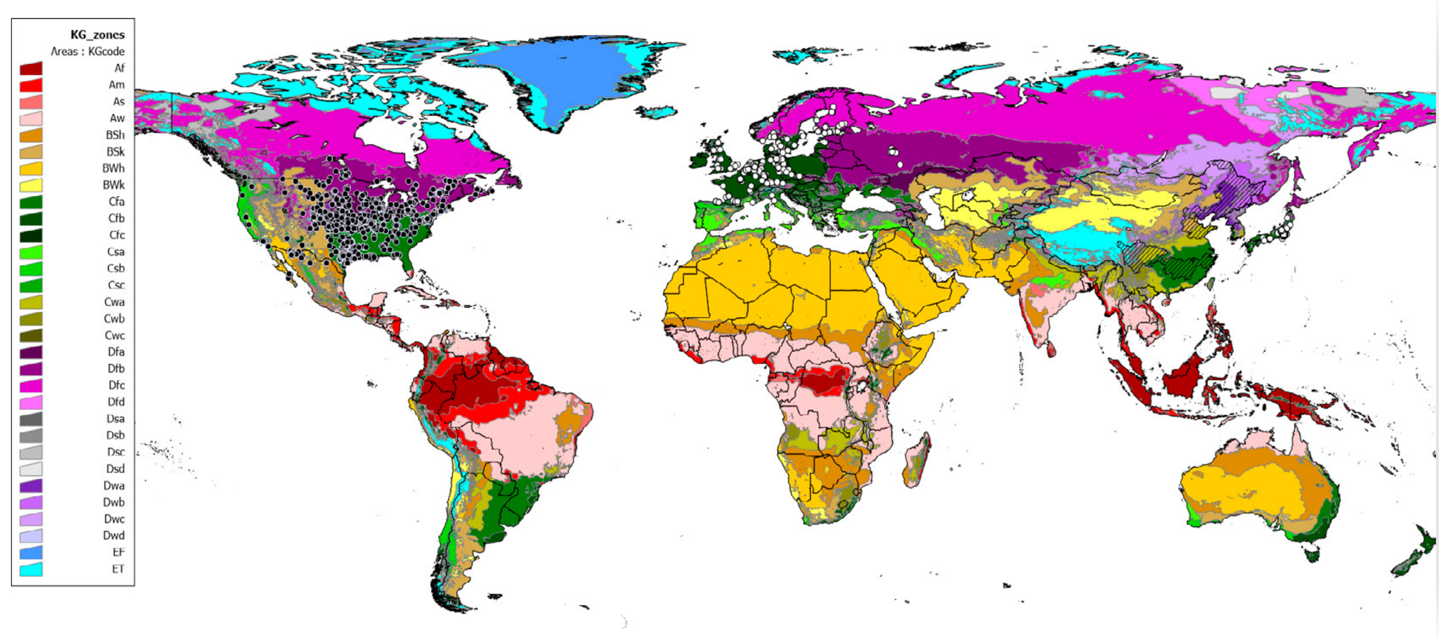


**Figure 2.** Worldwide distribution of *Ambrosia trifida* in relation to the modified Köppen-Geiger climate system.

In terms of the NAPPFAST system (Magarey et al., 2008), the great majority of the world distribution of *A. trifida* is found in zones 4 to 9, with a few locations in zone 3 in Canada, (Figure 3) corresponding to minimum annual temperature of -40°C to -9.4°C (see Table A2 in Annex). Since *A. trifida* is an annual species that survives the winter in the seed state, it is possible that its distribution is limited in cold climates not so much by low winter temperatures but by the lack of heat during the growing season. The absence of *A. trifida* from zones 10 to 13 may be related to the need for a cold period to break dormancy of the seeds (Davis et al., 2013).

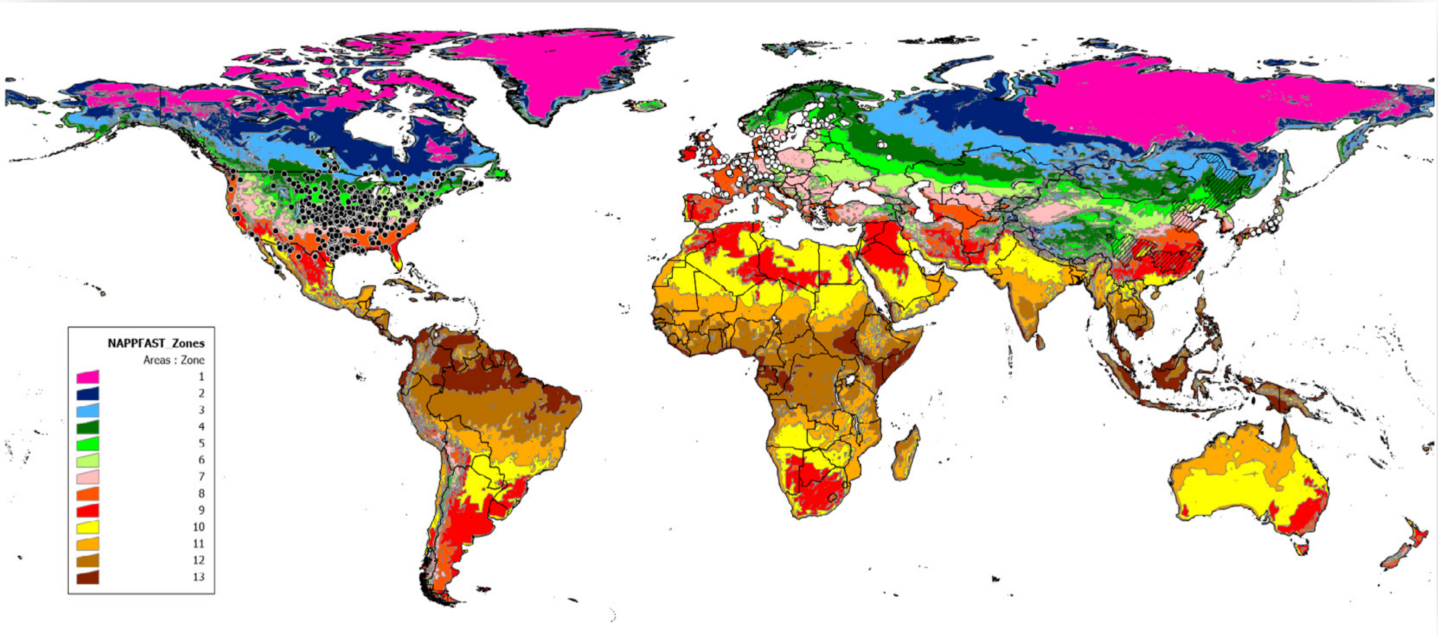


**Figure 3.** Worldwide distribution of Ambrosia trifida in relation to the NAPPFAST classification of cold hardiness zones.

In central and eastern Europe, *A. trifida* is associated with regions of more marked seasonality of precipitation (Follak et al., 2013).

#### 2.2.2.6. Methods of control

*Ambrosia trifida* is considered one of the most difficult weed species to control with herbicides due to its rapid growth, the occurrence of multiple flushes of germination, and the ability of the seeds to emerge from a depth of up to 15 cm where the applied herbicides do not penetrate the soil (Michigan State University, 2018).

There are many recommendations for control programs of *A. trifida* with herbicides, depending on the crop and production system (Johnson et al., 2007; United Soybean Board, 2016).

The control of *A. trifida* in the USA and Canada is complicated by the existence of many herbicide-resistant populations, including to Group 2 products (chlorimuron-ethyl, cloransulam-methyl, imazamox, imazaquin, imazethapyr, primisulfuron-methyl, prosulfuron) and Group 9 products (glyphosate). These populations include several resistant to multiple herbicides, including cases of combined resistance to Group 2 and Group 9 (Heap, 2018).

Several North American insect species have been introduced in Europe, China and Australia as biological control agents for *A. artemisiifolia* (Gerber et al., 2011). It is possible that some of these also attack *A. trifida* since they are generally genus-specific. An American beetle, *Ophraella communa*, accidentally introduced in Europe, seems to have a significant impact on the populations of *A. artemisiifolia* (Müller‐Schärer et al., 2014); its potential impact on A. trifida is unknown.

## 2.3. RISK EVALUATION

### 2.3.1. PROBABILITY OF INTRODUCTION AND SPREAD

#### 2.3.1.1. Probability of entry

**Natural dispersal**

Given the distances between the COSAVE region and the areas where *A. trifida* is present, and the lack of long-distance dispersal mechanisms in this species, natural dispersal does not appear to be an important entry pathway to the region.

**Unintentional introduction**

In Europe *A. trifida* was introduced as a contaminant of cereal grains and oilseeds imported from North America. Specifically, it arrived in Germany with imports of spring wheat seed before 1906, and Slovakia with grains imported from North America via the Soviet Union (Follak et al., 2013); these authors suggest that the frequency of introduction of *A. trifida* in Europe has decreased in recent times due to improvements in seed cleaning methods.

In Belgium (Verloove, 2006 ) indicates that *A. trifida* was introduced with imported grains and wool, without further details of the date of introduction or the source of the information.

(Mekky et al., 2010 ) reports that in grain of wheat, corn and sorghum imported into Egypt between 2009 and 2010, contamination with seeds of *Ambrosia* spp. (including *A. trifida*) was found in 3.7% of shipments originating in Ukraine, 1% in the USA, and 2.3% in Russia. The maximum level of contamination was 144 seeds per kg for Ukraine, 2 seeds per kg for the USA. and 4 seeds per kg for Russia.

In Australia, between 1994 and 1995, seeds of *A. trifida* were detected in imports of corn and sorghum from the USA and of soybean (origin not indicated) (Weed Technical Working Group, 1999).

(Karnkowski, 2001 ) reports many interceptions of *A. trifida* and other *Ambrosia* species in Russia, Finland and Poland, summarized in Table 1.

In Peru, *A. trifida* was detected on 43 occasions in shipments of corn and soybean grain imported from the USA in 2017 and 2018. In the period 2008 - 2016 there were no records of interception of *Ambrosia* (SENASA-PERÚ, 2018).

### Intentional introduction

No evidence of pathways for intentional introduction was found.

**Table 1. Interceptions of A. trifida and other Ambrosia species in products imported into some European countries, according to (Karnkowski, 2001 ).**

| Species | Product | Country(s) or region of origin | Importing country |
|---|---|---|---|
| *Ambrosia trifida* | Corn and sorghum grain | Canada, USA | Russia |
| | Soybean grain | USA | Russia |
| | Grass seed | Netherlands | Russia |
| | Rice grain | Japan | Russia |
| | Barley grain | France, Canada | Russia |
| | Soy meal | Germany, Netherlands, Brazil | Russia |
| | Corn, soybean and rye grain | North America | Finland |
| *Ambrosia* spp. | Corn and soybean grain, soy meal | USA | Poland |
| | Soybean grain | Canada | Poland |
| | Corn, wheat, triticale, soybean, millet, sunflower grain and corn meal | Hungary | Poland |
| | Corn, wheat, barley and sunflower grain | Slovakia | Poland |
| | Corn, sunflower and millet grain | Czech Republican | Poland |
| | Corn, wheat, millet, white mustard, buckwheat and sunflower grain and medicinal herbs | Ukraine | Poland |
| | Sunflower grain | Belarus | Poland |
| | Soybean grain | Netherlands, Romania | |
| | Corn and soybean grain | Austria | Poland |
| | Corn grain | France | Poland |
| | Sunflower and buckwheat grain | Russia | Poland |
| | Soybean meal | Germany | Poland |
| | Sunflower grain | Belarus | Poland |

The possible pathways of entry for *A. trifida* are summarized in Table 2.

**Table 2.** **Potential entry pathways for *Ambrosia trifida***

| Entry pathway | Probability | Uncertainty |
|---|---|---|
| 1. Contaminant of seed imported for sowing | medium | medium |
| 2. Contaminant of imported grain | low | medium |
| 3. Contaminant of imported wool | negligible | negligible |

### 2.3.1.2. Probability of establishment

The percentage of the territory of the member countries of COSAVE included in the most favorable climatic zones for *A. trifida* (BSk, Cfa, Cfb, Dfb) varies between 7.7% for Brazil up to 100% for Uruguay. If zones BSh, BWh, Csb, and Dfc, which are also within the climatic range of *A. trifida*, are added, these percentages increase slightly (Table 3). In the COSAVE region, the areas of zone NAPPFAST 1 and 2, outside the cold limit for *A. trifida*, are insignificant (Table A2 in Annex), indicating that this species would not be limited by low temperatures in any part of the region. In contrast, significant areas of Bolivia, Brazil and Peru are in zones 11 to 13, and probably have climates which are too tropical for *A. trifida* (Table 3).

Within the climatically favorable areas for *A. trifida*, habitats potentially suitable for establishment would include annual crop fields, disturbed and urban areas, vacant lots, roads and railways, wetlands and riparian areas. These habitats exist in all member countries of COSAVE

**Table 3.** **Percentage of the territory of each COSAVE member country included in the indicated Köppen-Geiger and NAPPFAST climate zones (see Annex 1, Tables A1 and A2).**

| Country | Köppen-Geiger zones | | NAPPFAST Zones |
|---|---|---|---|
| | BSk, Cfa, Cfb, Dfb | BSh, BSk, BWh, Cfa, Cfb, Csb, Dfb, Dfc | 3 - 10 |
| Argentina | 53.1% | 68.0% | 100.0% |
| Bolivia | 11.3% | 18.0% | 49.4% |
| Brazil | 7.7% | 13.5% | 12.2% |
| Chile | 14.3% | 33.1% | 81.7% |
| Paraguay | 36.2% | 54.5% | 99.9% |
| Peru | 8.4% | 17.8% | 32.4% |
| Uruguay | 100.0% | 100.0% | 99.0% |

Based on the above, the probability of establishment of *A. trifida* is rated as high with low uncertainty, considering the COSAVE region as a whole.

#### 2.3.1.3. Probability of spread

**Natural dispersal**

In Europe the dispersion of *A. trifida* has been relatively slow and it does not tend to colonize areas outside its main habitat, which are ruderal zones and railroads, perhaps due to its low fecundity and low seed viability (Follak et al., 2013 )

**Unintentional dispersal**

No specific data were found on the unintentional dispersion of *A. trifida*. It can be assumed that the seed can be transported as a contaminant of agricultural products such as grains and seeds from infested areas, and also by the movement of vehicles, agricultural machinery, or animals.

**Intentional dispersal**

*Ambrosia trifida* has no uses in agriculture, horticulture or as a medicinal plant. Therefore, there seems to be no motive for intentional dispersal.

Potential pathways of spread for *A. trifida* are summarized in Table 4.

**Table 4.** Potential pathways of spread for *Ambrosia trifida* within the COSAVE region

| Pathway of spread | Probability | Uncertainty |
|---|---|---|
| Natural dispersal by water or wind | low | low |
| Contaminant of agricultural products | medium | medium |
| Unintentional transportation with vehicles, agricultural machinery, or animals | medium | medium |
| Intentional dispersal, for example for seeding | negligible | low |
| Overall probability of spread | medium | medium |

Based on the above, the probability of spread of *A. trifida* is rated as medium with medium uncertainty.

### 2.3.2. CONCLUSION ON THE PROBABILITY OF INTRODUCTION AND SPREAD

Combining the probabilities according to the method of Annex 2, it is concluded that the overall probability of introduction and spread of *A. trifida* is rated as medium with medium uncertainty.

### 2.3.3. EVALUATION OF POTENTIAL ECONOMIC AND ENVIRONMENTAL CONSEQUENCES

#### 2.3.3.1. Economic effects

**Effects on crop yield or quality**

*Ambrosia trifida* is an important crop weed in North America, especially in soybean (*Glycine max*), sunflower (*Helianthus annuus*), bean (*Phaseolus* spp.), corn (*Zea mays*), wheat (*Triticum* spp.) and cotton (*Gossypium hirsutum*) (CABI, 2016). There is an extensive literature on its impacts and control. In experiments carried out in Missouri, USA, for two years, dense *A. trifida* populations reduced soybean seed yields by approximately 50% (Baysinger and Sims, 1991). There was also a 55% reduction in corn yield in Michigan (Michigan State University, 2018). A density of 1 plant of *A. trifida* per $m^2$ reduced the yield of sweet corn by approximately 40% and affected several parameters of crop quality (Williams and Masiunas, 2006). In Tennessee a density of 0.26 plants of *A. trifida* per metre of row reduced the yield of cotton by 50% (Barnett and Steckel, 2013).

In Northeast China *A. trifida* is considered one of the weeds that causes the most economic damage to wheat and other annual crops. It was found that the plant and its residues have allelopathic effects that reduce wheat growth (Kong et al., 2007).

All crops affected by *A. trifida* as weeds in the areas where it is currently present are of economic importance for the COSAVE region.

**Effects on production costs**

No specific and recent data on the effects of *A. trifida* on production costs were found. However, the need for herbicide application would probably entail additional costs for producers in the event that *A. trifida* becomes established in the region.

**Commercial effects**

Given that *Ambrosia trifida* is a prohibited or quarantine pest in several countries (see 2.1.2.), its presence in a COSAVE member country could have an impact on market access for exported products such as grains or seeds.

**Social effects**

The pollen of *Ambrosia* spp. (including *A. trifida*) is an important cause of allergies that produce serious suffering in affected populations and areas (see 2.4.3).

#### 2.3.3.2. Environmental effects

**Effects on plant species**

In general, *A. trifida* is a species that colonizes disturbed and cultivated areas that do not tend to have great importance for biodiversity (Plank et al., 2016), and therefore, few impacts on native plant species or communities have been identified in areas where *A. trifida* has invaded. However, in Japan the diversity of plant species had a negative correlation with abundance of *A. trifida* in a riparian natural reserve near Tokyo (Miyawaki and Washitani, 1996), and unspecified impacts on native plants such as *Primula sieboldii* E. Morren (Primulaceae) are reported. (National Research and Development Agency, 2018).

**Effects on ecological systems or processes**

No evidence was found of effects of *A. trifida* on ecological systems or processes.

#### 2.3.3.3. Non-phytosanitary effects

Species of *Ambrosia* (including *A. trifida* and *A. artemisiifolia*) are among the most important causes of respiratory allergies (hay fever) in North America and Europe, due to their abundant production of wind-dispersed pollen. In Germany it was calculated in 2003 that the annual economic cost of allergies caused by *A. artemisiifolia* was between €20 - €50 million (USD25 - 62 millions), and in a single hospital in Italy the annual cost for allergy treatment of *Ambrosia* was € 1.3 million

(USD $1.63 millions) (Plank et al., 2016). With climate change and the increase of atmospheric $CO_2$ it is expected that pollen production by *Ambrosia* spp. will increase (Rogers et al., 2006).

#### 2.3.4. CONCLUSIONS ON POTENTIAL ECONOMIC AND ENVIRONMENTAL CONSEQUENCES

Summing up all the potential consequences identified, they are rated as high with low uncertainty.

### 2.4. SUMMARY OF THE POTENTIAL RISK OF *AMBROSIA TRIFIDA*

*Ambrosia trifida* is a species of great importance as a weed of crops, difficult to control and causing significant yield reductions in several crops. There are suitable conditions for its establishment in all the countries of the region. The entry pathway that presents the highest degree of risk to the region is the importation of contaminated seed for planting. The potential risk of *A. trifida* for the COSAVE region is summarized in Table 5.

**Table 5.** Summary of the potential risk of *Ambrosia trifida* for the COSAVE region.

| | Risk rating | Uncertainty |
|---|---|---|
| Probabilities of entry | | |
| 1. Contaminant of seed imported for sowing | Medium | Medium |
| 2. Contaminant of imported grain | Low | Medium |
| 3. Contaminant of imported wool | Negligible | Negligible |
| Probability of establishment | High | Low |
| Probability of spread | Medium | Medium |
| Overall probability of establishment and spread | Medium | Medium |
| Consequences | | |
| Potential economic and environmental consequences | High | Low |

# 3. STAGE III: PEST RISK MANAGEMENT

Based on the foregoing, it is recommended that *Ambrosia trifida* be included in the list of quarantine pests, and that the following phytosanitary measures be applied:

Requirements for imported seed for sowing:

**DA[1] 5.** The place of production / site of production site / field, was inspected during the growing season and found to be free of *Ambrosia trifida*,

or

**DA 15.** The shipment is free of *Ambrosia trifida*, according to the result of an official laboratory analysis.

1 Additional Declaration (DA) statement that is required by an importing country to be entered on a phytosanitary certificate and which provides specific additional information on a consignment in relation to regulated pests or regulated articles ( ISPM n°5)

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# ANNEX 1: CLIMATIC TABLES

**Table A1.** Percentage of the territory of each COSAVE member country corresponding to each of the climatic zones of the Köppen-Geiger system. Calculated using the March 2017 updated version with data from 1986-2010 and with a resolution of 5 minutes, according to Kottek and Rubel[2].

| ' | | Country | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Argentina | Bolivia | Brazil | Chile | Paraguay | Peru | Uruguay |
| Af | Equatorial rainforest, fully humid | | 2.24 | 16.07 | | 0.69 | 41.38 | |
| Am | Equatorial monsoon | | 13.39 | 20.48 | | 4.94 | 9.62 | |
| As | Equatorial savannah with dry summer | | | 2.56 | | | | |
| Aw | Equatorial savannah with dry winter | | 46.43 | 46.06 | | 37.00 | 4.98 | |
| BSh | Steppe climate, hot | 7.13 | 6.62 | 5.76 | | 18.26 | 1.67 | |
| BSk | Steppe climate, cold | 25.02 | 8.98 | | 3.05 | | 1.95 | |
| BWh | Desert climate, hot | 2.08 | 0.02 | <0.01 | 0.67 | | 7.73 | |
| BWk | Desert climate, cold | 6.06 | 5.52 | | 25.52 | | 4.08 | |
| Cfa | Warm temperate, fully humid, hot summer | 23.76 | 0.52 | 6.89 | | 36.21 | | 99.17 |
| Cfb | Warm temperate, fully humid, warm summer | 4.36 | 1.85 | 0.82 | 11.23 | | 6.48 | 0.83 |
| Cfc | Warm temperate, fully humid, cool summer and cold winter | 1.22 | 0.05 | | 12.65 | | 0.18 | |
| Csb | Warm temperate with dry, warm summer and cold winter | 5.67 | | | 18.11 | | | |
| Csc | Warm temperate with dry, cool summer and cold winter | 0.74 | | | 1.07 | | | |
| Cwa | Warm temperate with dry winter, hot summer | 15.85 | 2.51 | 1.15 | | 2.90 | | |
| Cwb | Warm temperate with dry winter, warm summer | 1.98 | 6.01 | 0.21 | | | 4.66 | |
| Cwc | Warm temperate with dry winter, cool summer and cold winter | 0.45 | 0.60 | | | | 0.73 | |
| Dfb | Snow climate, fully humid, warm summer | <0.01 | | | | | | |
| Dfc | Snow climate, fully humid, cool summer and cold winter | 0.02 | | | | | | |
| Dsc | Snow climate with dry, cool summer and cold winter | 0.07 | | | 0.02 | | | |
| Dwb | Snow climate with dry winter, warm summer | 0.01 | | | | | | |
| Dwc | Snow climate with cool summer and cold, dry winter | 0.02 | | | | | | |
| EF | Polar climate | 0.01 | | | 0.02 | | 0.01 | |
| ET | Tundra climate | 5.55 | 5.25 | | 27.64 | | 16.51 | |

2 Kottek, M. and F. Rubel. 2017. World Maps of Köppen-Geiger Climate Classification. Accessed online January 10 2018. http://koeppen-geiger.vu-wien.ac.at/present.htm

**Table A2.** Percentage of the territory of each COSAVE member country corresponding to each of the NAPPFAST cold hardiness zones[3].

| NAPPFAST Zone | Mean annual extreme minimum temperature (°C) | Country | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Argentina | Bolivia | Brazil | Chile | Paraguay | Peru | Uruguay |
| 1 | < -45.6 | <0.01 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | -45.9 — -40.0 | 0.01 | 0.00 | 0.00 | 0.02 | 0.00 | 0.00 | 0.00 |
| 3 | -40.0 — -34.4 | 0.07 | 0.00 | 0.00 | 0.01 | 0.00 | 0.00 | 0.00 |
| 4 | -34.4 — -28.9 | 0.67 | 0.00 | 0.00 | 0.25 | 0.00 | 0.00 | 0.00 |
| 5 | -28.9 — -23.3 | 2.09 | 0.15 | 0.00 | 1.07 | 0.00 | 0.00 | 0.00 |
| 6 | -23.3 — -17.8 | 4.22 | 1.70 | 0.00 | 4.78 | 0.00 | 0.93 | 0.00 |
| 7 | -17.8 — -12.2 | 7.45 | 9.74 | 0.00 | 11.47 | 0.00 | 5.31 | 0.00 |
| 8 | -12.2 — -6.7 | 17.25 | 12.07 | 0.07 | 16.17 | 0.00 | 7.87 | 0.00 |
| 9 | -6.7 — -1.1 | 46.69 | 10.64 | 3.69 | 26.29 | 4.46 | 9.35 | 80.22 |
| 10 | -1.1 — 4.4 | 21.55 | 15.11 | 8.43 | 21.67 | 95.46 | 8.91 | 18.74 |
| 11 | 4.4 — 10.0 | 0.00 | 38.51 | 18.52 | 14.30 | 0.08 | 19.59 | 1.03 |
| 12 | 10.0 — 15.6 | 0.00 | 12.08 | 44.55 | 3.93 | 0.00 | 42.89 | 0.00 |
| 13 | > 15.6 | 0.00 | 0.00 | 24.73 | 0.04 | 0.00 | 5.14 | 0.00 |

3 Calculated with data courtesy of Dr. R. Magarey, see Magarey, R.D., D.M. Borchert and J.W. Schlegel. 2008. Global plant hardiness zones for phytosanitary risk analysis. *Scientia Agricola* 65: 54-59.

## ANNEX 2: METHOD OF COMBINING PROBABILITIES AND UNCERTAINTIES

To rate the overall risk of establishment and spread, each probability is converted into a numerical score (negligible = 0, low = 1, medium = 2, high = 3), and the numerical scores are multiplied as follows:

*Probability of establishment and spread*
=
*Probability of establishment*
*x*
*Probability of spread*

This product is used to rate the overall probability of introduction and spread as follows:

| Product (probability of establishment × probability of spread) | Overall rating for probability of establishment and spread |
|---|---|
| 0 | Negligible |
| 1 – 3 | Low |
| 4 – 6 | Medium |
| >6 | High |

Similarly, the uncertainty levels of the probabilities of establishment and spread are combined to arrive at an uncertainty score for the overall probability of establishment and spread. As before, the levels of uncertainty are converted into numerical scores (negligible = 0, low = 1, medium = 2, high = 3). Unlike the probabilities, the uncertainties are added:

*Uncertainty of the probability of establishment and spread*
=
*Uncertainty of the probability of establishment*
+
*Uncertainty of the probability of spread*

This sum is used to rate the uncertainty of the overall probability of establishment and spread as follows:

| Sum of uncertainty scores for the overall probability of establishment and spread | Overall uncertainty rating for the probability of establishment and spread |
|---|---|
| 0 | Negligible |
| 1 | Low |
| 2 – 3 | Medium |
| 4 – 6 | High |