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MAIN INSPECTORATE OF PLANT PROTECTION

CENTRAL LABORATORY

Pest Risk Analysis and Pest Risk Assessment for the territory of the Republic of Poland (as PRA area) on *Ambrosia* spp. (updated version)

by

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CONTENTS

PEST RISK ANALYSIS

Introduction

A Pest Risk Analysis (PRA) of the territory of the Republic of Poland (as PRA area) was carried out on the basis of information compiled in the format of EPPO PRA Guideline no. 1 “Check-list” of information required for PRA (OEPP/EPPO, 1993) (Part A) with some modification caused by the nature of the pest - weeds are not considered by the author of standard “Check-list” to be analysed.

PART A. INFORMATION FOR PRA

Section 1. The organism

1.1. Name and taxonomic position

There are over 40 species of the genus *Ambrosia*. The most economic importance have three species: common ragweed (*Ambrosia artemisiifolia),* perennial ragweed *(Ambrosia psilostachya)* and giant ragweed (*Ambrosia trifida).* These weeds seem to possess the highest potential phytosanitary risk for Poland. So, only they are subjects of this PRA.

***Ambrosia* spp.**

Name: *Ambrosia artemisiifolia* L.
Synonyms: *Ambrosia elatior* Linn., *A. elata* Salisb., *A. paniculata* Muhl.
Taxonomic position: Asteraceae
Common names: Common ragweed (English)
Petite herbe a poux (French)
Name: *Ambrosia psilostachya* DC.
Synonyms: *Ambrosia coronopifolia* T.&G., *A. peruviana* DC., *A.. psilostachya* DC. var. *coronopifolia* (T.& G.)
Taxonomic position: Asteraceae
Common names: Perennial ragweed, western ragweed (English)
L’herbe a poux vivace (French)
Name: *Ambrosia trifida* L.
Synonyms: *Ambrosia integrifolia* Muhl.
Taxonomic position: Asteraceae
Common names: Giant ragweed, kinghead, tall ragweed (English)

1.2. Relationship with known quarantine pests

There is no relationship with known quarantine pests.

1.3. Methods for identification for inspection purposes

Ambrosia artemisiifolia and *A. trifida* are annual plants spreading by seeds. The stem of *A. artemisiifolia* (fig. 1 /1/) is erect, bushy branched, rough, hairy, 0.3 to 1.2 m high. Leaves are nearly smooth, opposite or alternate, short stalked, thin, usually twice divided into narrow segments. Floral heads are of two kinds: male (staminate) heads and female (pistillate) heads. Male heads (fig. 1 /2/) contain usually 10 – 100 pollen-producing flowers and they are in spikes terminating the stems and branches. Female heads are 1-flowered, sessile and inconspicuous. They occur in small clusters or single in the axils of the upper leaves (Payne, 1963; Frankton and

Mulligan, 1970; Bassett and Crompton, 1975; Wax et al., 1981; Shamonin and Smetnik, 1986). In the field, there is very great variability of sex expression. Plants differ significantly in gender in different locations within the fields (McKone and Tonkyn, 1986).

As another *Ambrosia* species, *A. artemisiifolia* produces so called siconia which consist of achenes and achenes woody coat. Achenes of this species are eggshaped and their pericarp is thin, rough, glazy or dull, blackish. Syconium is egg-cub-shaped, almost cylindrical, with crown of sharp and thin dents (usually 6) surrounding the apex surface, 2.5 – 5.0 mm long, 1.2 – 2.2 mm in diameter (fig. 1 /7/). The colour of syconium is greenish-yellow to brown (Frankton and Mulligan, 1970; Bassett and Crompton, 1975; Wax et al., 1981; Shamonin and Smetnik, 1986; Kulpa and Desowska, 1988). The genetic variability of the shape of siconia produced by plants from various populations is observed.

However, siconia of *A. artemisiifolia* are very similar to these of *A. maritima* L., the species native to Southern Europe, Asia Minor and Africa. In general, siconia of these two species can be distinguished using electrophoresis technique. The identification is based on electrophoretic patterns of alcohol dehydrogenase (ADH) and 6-phosphogluconate dehydrogenase (6PGD) (Triest et al., 1989).

The stem of *A. trifida* (fig. 2 /1/) is erect, rough hairy, usually 1 – 3 m high. However, in the North America it reaches a high of 3.6 to 5.4 m. Leaves are opposite, hairy, long-petioled, prominently 3-lobed, but unlobed or 5-lobed leaves may occur, also on the same plant. Flower heads contain either male or female flowers. Male (staminate) heads (fig. 2 /2/) are in spikes terminating the stems and branches. Female (pistillate) heads are 1-flowered, sessile and inconspicuous. They occur in small clusters (up to 3 pieces) or single in the axils of the upper leaves (Payne, 1963; Frankton and Mulligan, 1970; Bassett and Crompton, 1975; Wax et al., 1981; Shamonin and Smetnik, 1986).

As another *Ambrosia* species, *A. trifida* produces so called siconia which consist of achenes and achene woody coats. Syconium of this species is large, cup-shaped, narrow at a bottom, with crown of thick, sharp dents at 2/3 of fruit's length (usually 5 – 7) surrounding the apex surface, 5.0-10.0 mm long, 4.0-8.0 mm wide (fig. 2 /5/). The colour of syconium is yellow to light brown (Frankton and Mulligan, 1970; Wax et al., 1981; Bassett and Crompton, 1982; Shamonin and Smetnik, 1986; Kulpa and Desowska, 1988).

A. psilostachya is a perennial plant, spreading especially by creeping roots and rarely by seeds. The stem of this plant (fig. 3 /6/) is erect, branched or unbranched, usually to 1 m high. Leaves are most opposite below and alternate above, sessile or on short petioles, ovate-lanceolate, pinnately to bi-pinnately lobed. The colour of leaves is light green to greyish green. Flower heads contain either male or female flowers and are on different parts of the same plant. Male (staminate) heads (fig. 3 /1/) contain usually 10 – 40 pollen producing flowers and they are in spikes terminating the stems and branches. Female (pistillate) heads are 1-flowered, sessile. They occur in small clusters or single in the upper axils. The root system of this species is well developed. It consists a lot of horizontal running rootstocks which allow the spread of the plant (Payne, 1963; Frankton and Mulligan, 1970; Bassett and Crompton, 1975; Wax et al., 1981; Shamonin and Smetnik, 1986).

As another *Ambrosia* species, *A. psilostachya* produces so called siconia which consist of achenes and achene woody coats. Siconia of this species is inversely egg-shaped, with delicate pubescence and a crown of knobs (instead of dents), which may be absent, 3.0 – 6.0 mm long, and 3.5 mm wide (fig. 3 /4/). The colour of syconium is grey-yellowish with green to brown tint (Frankton and Mulligan, 1970; Bassett and Crompton, 1975; Wax et al., 1981; Shamonin and Smetnik, 1986; Kulpa and Desowska, 1988).

Using above-mentioned characters it is possible to distinguish plants and fruits (siconia) of *Ambrosia* from these of other species.

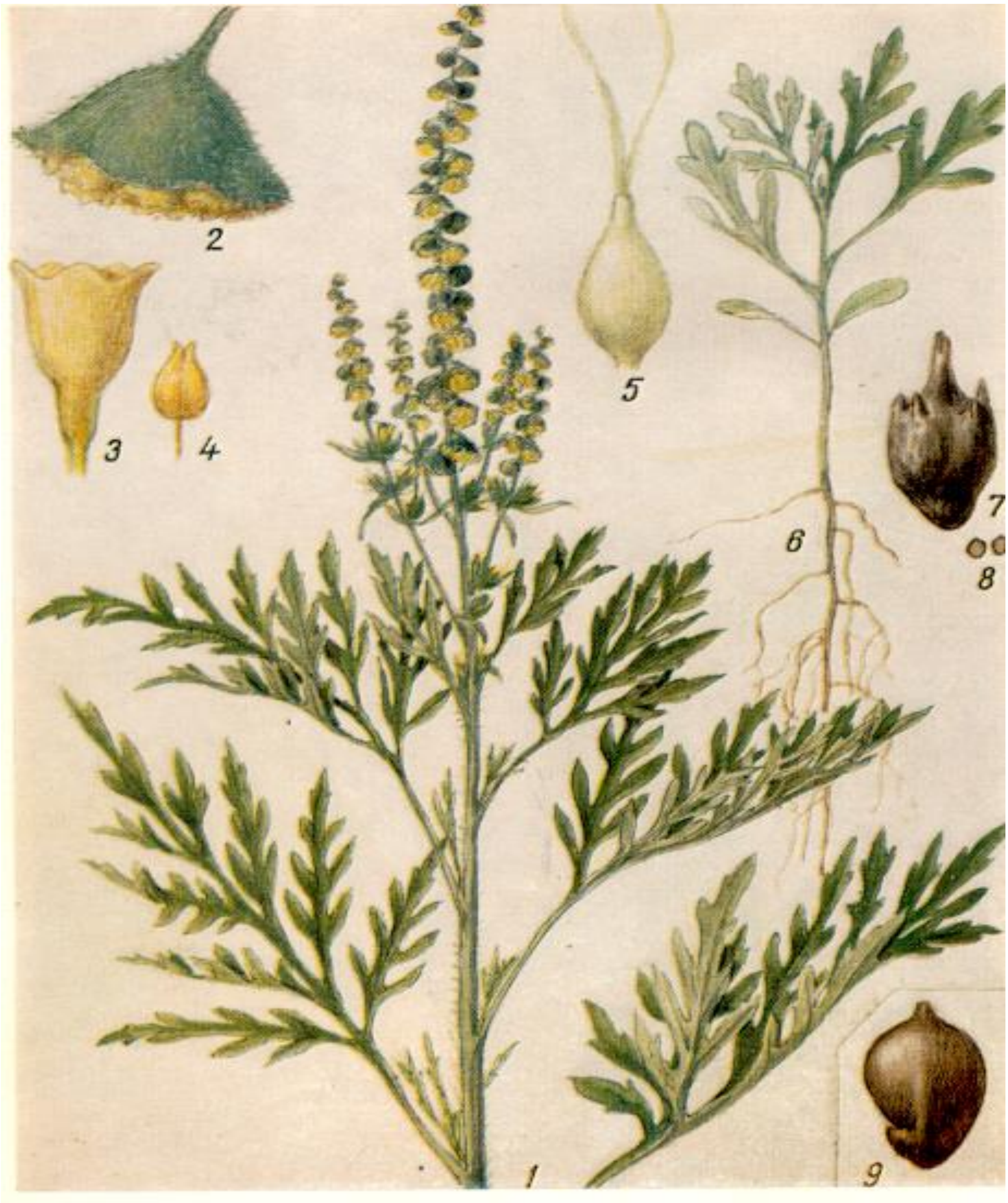

Fig. 1 Common ragweed (*Ambrosia artemisiifolia)*

1. upper portion of plant; 2. male head; 3. male flower; 4. stamen; 5. female flower; 6. young plant; 7. syconium; 8. natural size of siconia; 9. achene (from Shamonin and Smetnik, 1986).

Fig. 2 Giant ragweed (*Ambrosia trifida)*

1. upper portion of plant; 2. young plant; 3. male head; 4. female flower; 5. syconium; 6. natural size of siconia (from Shamonin and Smetnik, 1986).

Fig. 3 Perennial ragweed (*Ambrosia psilostachya)*

1. male head; 2. female flower; 3. natural size of siconia; 4. syconium; 5. a part of root system; 6. upper portion of plant; 7. leaf (from Shamonin and Smetnik, 1986).

1.4. Methods for detection

It is necessary to detect:

- plants of *Ambrosia* growing in different habitats,
- siconia of the weeds contaminated different stored products.

Surveys for the detection of *Ambrosia* plants should be conducted especially in: different crops (cereals, maize, soya bean, sunflower, root crops etc.), on ruderal places, waste lands, lawns, places near roads, railway tracks, warehouses, surroundings of oil mill and grain processing factories, fodder industry factories based on imported commodities. During this inspection the inspector usually walks across surveyed field, lawn etc. and along their borders, along roads, railway tracks etc. paying attention to all plants having features of *Ambrosia* spp., as described under paragraph 1.3. Suspected plants are identified in the field or in the laboratory using hand lens or the stereoscopic microscope.

Methods used during examination of stored products (i.e. seeds, grain, fodder materials etc.) to detect siconia of *Ambrosia* spp. depend on the size of siconia of particular ragweed species and particles of the products. For instance, for detection of siconia of *A. trifida* in samples of maize or soya bean grains visual inspection of the product spread in thin layer usually is performed. When the difference between the size of the siconia and the particles is distinct (for instance in case of occurrence of *A. artemisiifolia* in samples of the grain of maize, seeds of sunflower etc.), samples may be sieved on sieves. Usually, sets containing sieves of 1.0, 2.0 and 3.0 mm pore size are used (Shamonin and Smetnik, 1986).

All seeds and fruits of weeds similar to achenes and siconia of *Ambrosia* spp. are collected into glass vials and taken to the laboratory for identification. The identification is made using descriptions of the weeds and collections of their seeds and fruits. In doubtful cases collected siconia are sown into pots and the identification of plants grown from them is made.

Section 2. Biological characteristics of the pests

<u>Ambrosia artemisiifolia</u>

Rate of development

In conditions of southern part of Canada the rate of ragweed plants growth is at its peak in July and August. Mature seeds are formed on plants in late August and early September (Bassett and Crompton, 1975). There is one generation of plants and fruits during the one vegetation cycle.

Possible number of reproduction stages per growing season

Reproduction of *A. artemisiifolia* takes place by generative means, only. Small plant of this weed produces approximately 3000 seeds, while large plant produces up to 100,000 seeds in one growing season (Bassett and Crompton, 1975; Savotikov and Smetnik, 1985). No vegetative reproduction is known.

Typical timing of the life cycle in the growing season and relation to that of host plants

Ambrosia artemisiifolia is an annual herb. In the natural habitat seeds germinate only in spring and the peak of germination occurs in early to mid-spring (Baskin and Baskin, 1980). These authors found, that in Kentucky, USA in early spring at simulated habitat temperatures seeds of *A. artemisiifolia* had germinated well in light but not in darkness. However, they germinated well in darkness at temperatures characteristic of the habitat in late spring and summer. In conditions of

Ottawa, Ontario, Canada 90% of the total emergence occurred before 15 June (Bassett and Crompton, 1975). In Ithaca, New York, USA the same percentage of the total emergence in test plots occurred before 9 June (Dickerson, 1968). In Michigan, USA the total seasonal emergence of common ragweed occurred between 20 April and 4 May. Although seedlings were recorded in June they were fewer in number and very few seedlings emerged during the month of July (Gebben, 1965).

Berés (1994) found that in Hungary plants germinating later had shortened period between their germination and ripening from 183 to 115 days. The phase between germination and blooming of such plants shortened from 119 do 24 days.

Bazzaz (1974) stated that in the eastern part of the United States the seeds of. *A. artemisiifolia* had germinated at or near the soil surface in early spring, and the cotyledons had become green shortly after their emergence.

In southern Illinois, USA, fields are usually abandoned after corn cultivation. Bazzaz (1968) found that in the first season after abandonment, *Ambrosia artemisiifolia* had been dominant in fields sampled during the 3rd week of July. In the 2nd year, common ragweed was also abundant (frequency 97%), but few individuals were more than 15 cm tall. In the 3rd year common ragweed had a frequency of 80%; however, the plants were rather small and inconspicuous. In the 4th year, common ragweed was not listed in the plants dominating the undisturbed fields.

In Russia florescence of this weed starts in late July and lasts until October. Fructification occurs in September and October (Shamonin and Smetnik, 1986). In Middle Europe florescence occurs usually from August to October and mature seeds are produced in October (Poscher, 1997). The emergence, florescence and fructification occur later in comparison with such cultivated plants as cereals and fodder plants (Kott, 1953).

There are no detailed data on biology of *A. artemisiifolia* in Poland. However, in botanical garden of Medical Academy in Poznań, Department of Medicinal Plants, plants of this species grew, flowered and fruited without any complication or special treatment (Błoszyk et al., 1991; Poscher, 1997).

Dissemination and dispersal

Siconia play the major role in dispersal of the weed. They possess no obvious dispersal mechanism. Gebben (1965) states that water, birds and man disperse seeds of *Ambrosia artemisiifolia*. Apparently, wind plays a minor role in dispersal (Gebben, 1965; Dickerson, 1968).

Survival under adverse conditions

Seeds of *Ambrosia* may survive for many years in conditions insufficient for the development of the plants. Toole and Brown (1946) mentioned, that seeds of *A. artemisiifolia* can remain viable for 39 years or even more when buried in the soil. Dickerson (1968) noted, that seeds of this species subjected to frost for several months' storage exhibited from 25 to 86% viability.

Common ragweed is able to adapt to mowing, trampling and grazing. In an experiment carried out at Ottawa, Ontario, Canada, 48 plants grown in a waste lot and averaging 5 cm height at the end of May were cut slightly above the cotyledon leaves. A week later 40 of 48 plants were growing quite normally. Also in surveying several grain fields near Ottawa, it was observed that ragweed plants cut in July developed several new stems and flowered about 10 days later than adjacent uncut plants. Several cuttings, therefore, are required in August to prevent flowering and seed development (Bassett and Crompton, unpublished data). Common ragweed responds to, and counteracts the effects of, cultivation and ploughing by the longevity of its seeds (Toole and Brown, 1946).

Adaptability

Ambrosia artemisiifolia is an organism with remarkable flexibility in its biology. It has demonstrated this flexibility in exploiting new situations in such countries as Russia and Hungary. In these countries this weed was able to enter the ecosystem in areas far outside its normal geographical range and adapted to different climatic and soil conditions (Berés and Hunyadi, 1980; Kovalev, 1989). This ragweed species produces different forms (varieties) as an effect of adaptation to different conditions (Tacik, 1971). However, Nedolushko (1984) observed in Russia that this weed could not invade established meadows and lawns.

Bazzaz (1970) suggested that complex germination behaviour of *A. artemisiifolia* had ecological adaptations which allowed this species to colonise disturbed areas and to maintain large populations on them.

Raynal and Bazzaz (1975) found that in Illinois, USA, *A. artemisiifolia* exhibited plasticity in response to intense competition in fields dominated by *Erigeron annuus* and *E. canadensis* and its population level remained constant throughout the growing season.

Bazzaz (1974) stated, that *A. artemisiifolia* dominated on abandoned fields after spring plowing in many parts of the eastern United States.

Kosola and Gross (1999) state that below-ground competition was the dominant factor suppressing plants of *A. artemisiifolia* in 2-year-old abandoned fields in south-western Michigan, USA.

Lebedeva (1993) states that in heavily infested areas in North America as well as in Russia *A . artemisiifolia* is a dominant species in the first phase of old-field succession. In Russia because of absence of natural enemies and very high degree of competition of this weed with another plants, *A. artemisiifolia* overgrows different annual weeds and slightly delay the second phase of the succession.

Unfortunately, no analysis of DNA profiles of specimens of different varieties of the same species of *Ambrosia*, as well as of specimens of the same species originating in different geographical areas has been made, so far (Bassett and Crompton, 1975).

Ambrosia psilostachya

Rate of development

Wagner and Beals (1958) carrying out field studies in Michigan, found that the pollen and morphological development of perennial ragweed preceded that of the common ragweed by 2-3 wk, so much later than such cultivated plants as cereals and fodder plants. In Russia the seeds of this ragweed germinate in early May. In late July young plants start to produce creeping roots (Savotikov and Smetnik, 1995).

Possible number of reproduction stages per growing season

Reproduction takes place largely by vegetative means. Seed production of this plant is of secondary importance in its survival and spread (Bassett and Crompton, 1975). However, the seeds can have some importance in introduction of the weed to some areas where it up till now has not occurred (Shamonin and Smetnik, 1986). No specific information is available on the viability of seeds and germination (Bassett and Crompton, 1975).

Typical timing of the life cycle in the growing season and relation to that of host crops

Ambrosia psilostachya is a perennial plant. Plants of this weed emerge much later than crop plants (sunflower, wheat, perennial grasses). Perennial ragweed invades grassy fields. The reproductive strategy appears similar in all habitats but the plant prefers sandy or gravely well-drained soils. Florescence of *A. psilostachya* occurs from August to October.

Dissemination and dispersal

A. psilostachya is spread primarily by creeping roots. Through its spreading rootstock, given area can be readily colonised by one or a few original plants despite the small seed set (Bassett and Crompton, 1975). According to the results of research conducted in Poland, the genetically identical plants of *A. psilostachya* were found on more than 100 m^2 area (Krasicka-Korczyńska, personal comm.). Wagner and Beals (1958) observed, that a few more lateral branches may tend to develop from axillary buds as the season progresses, thus extending the potential flowering time. The plant of *A. psilostachya* produces only one seed per flowering head (Bassett and Crompton, 1975). Wagner and Beals (1958) counted 118 flowering heads from one plant from which only 66 developed to maturity. Since reproduction takes place largely by vegetative means, seed production in this plant is of secondary importance in its survival and spread. No specific information is available on the viability of seeds of *A. psilostachya* (Bassett and Crompton, 1975).

Survival under adverse conditions

A. psilostachya survives primarily by spreading roots. Savotikov and Smetnik (1995) noted that small parts of creeping roots of *A. psilostachya* can survive very well, but they did not mention the time of such a survival. In southern Saskatchewan and Manitoba (Canada), where the winters are extremely cold (the minimal temperature achieves from -40 to -50^{0}C), the roots are able to survive and continue growing in following spring (Bassett and Crompton, 1975). However, no detailed data on climatic requirements is available for *A. psilostachya*.

Adaptability

Ambrosia psilostachya is an organism with remarkable flexibility in their biology. It has demonstrated this flexibility in exploiting new situations in different countries. This ragweed species produces different forms (varieties) as an effect of adaptation to different conditions (Tacik, 1971). For instance, *A. psilostachya* var. *psilostachya* occurs probably in the USA (California) only, and it seems not to show larger expansiveness. The second form – *A . psilostachya* var. *coronopifolia*, known also as *A. coronopifolia*, has been spread to Europe (Tacik, 1971).

Unfortunately, no analysis of DNA profiles of specimens of different varieties of the same species of *Ambrosia*, as well as of specimens of the same species originating in different geographical areas has been made (Bassett and Crompton, 1975).

Ambrosia trifida

Rate of development

In conditions of southern part of Russia the weed emerges in late April and early May, and mature seeds are formed on plants in September (Shamonin and Smetnik, 1986; Savotikov and Smetnik, 1995). The same time of germination has been observed in Quebec, Canada, but in Illinois, USA germination has been observed in early March (Bassett and Crompton, 1982). The maximum height of the plants was observed in July (Quebec) or in early August (Illinois) (Bassett and Crompton, 1982). In Middle Europe florescence occurs from September to October (Poscher, 1997). There is one generation of plants and fruits during the one vegetation cycle.

Possible number of reproduction stages per growing season

Reproduction of *A. trifida* takes place by generative means, only. One plant of *Ambrosia trifida* produces up to 5.000 seeds (Kott, 1953). No vegetative reproduction is known. No specific information on the viability of seeds and germination is available. However, Bassett and Crompton (1982) observed that the treatment of scarified seeds by the alternating temperatures from 2 to 20^0C every week for 2-month duration after April resulted in no further germination.

Tieng (1963) states that seed dormancy of this species may be broken by gibberelic acid, thiourea and other SH group compounds. This author also found that pure coumarin, glutaric acid and citric acid were all inhibitors.

Typical timing of the life cycle in the growing season and relation to that of host crops

Ambrosia trifida is an annual herb. In Southern part of Russia emergence of the weed occurs in late April and early May, florescence occurs in June, the forming of seeds starts in July and mature seeds are formed in September (Shamonin and Smetnik, 1986; Savotikov and Smetnik, 1995). In Ottawa, Canada the florescence occurs between 13 July and 4 August (Bassett and Crompton, 1982). Emergence starts when the temperature achieves 5 – 6^0C and lasts 7 – 90 days. Optimal temperature for the plant emergence is 20 – 25^0C. In these conditions plants emerged from 70% of seeds. If the temperature achieves 30^0C the seeds often become dormant and don't germinate for long time. The emergence, florescence and fructification occurs later in comparison with such cultivated plants as cereals and fodder plants (Kott, 1953) and later than *A. artemisiifolia* (Bassett and Crompton, 1982).

There are no detailed data on biology of *A. trifida* in Poland. However, in botanical garden of Medical Academy in Poznań, Department of Medicinal Plants, plants of this species grew, flowered and fruited without any complication or special treatment (Błoszyk et al., 1991; Poscher, 1997).

Dissemination and dispersal

Ambrosia trifida is spread primarily by siconia. The possibility of spread of siconia of *A. trifida* is higher than of siconia of *A. artemisiifolia* because of earlier fructification and better flotation. They may be easily spread by the rainwater (Savotikov and Smetnik, 1995). No specific information on the viability of seeds of *A. trifida* is available (Bassett and Crompton, 1975).

Survival under adverse conditions

The is, in general, lack of specific information concerning survival of *A. trifida*. However, Bassett and Crompton (1982) state that during an experiment carried out at Hull, Quebec, Canada, upper stems of 50 plants of *A. trifida* at the three-leaf stage. Forty-three of cut plants produced new branches and eventually produced inflorescence, flowering 10 days later than undamaged plants.

Adaptability

Ambrosia trifida is an organism with remarkable flexibility in their biology. It has demonstrated this flexibility in exploiting new situations in different countries (no specific data available).

Unfortunately, no analysis of DNA profiles of specimens of different varieties of the same species of *Ambrosia*, as well as of specimens of the same species originating in different geographical areas has been made (Bassett and Crompton, 1975).

Section 3. Geographical distribution of the pests

3.1. Present distribution in PRA area

Plants of the genus *Ambrosia* occur in Poland. The species *A. artemisiifolia, A. psilostachya* and *A. trifida* have been found, so far. Their distribution in general is limited to ruderal places, waste lands, lawns, places near roads, sea ports, railway tracks, warehouses, surroundings of oil mill and grain processing factories, fodder industry factories based on the commodities imported from the USA (Tacik 1971; Misiewicz, 1976; Sowa and Warcholińska, 1992; Krasicka-Korczyńska and Korczyński, 1995; Guzik and Sudnik-Wójcikowska, 1997; Poscher, 1997; Rutkowski, 1998). *A. artemisiifolia* and *A. psilostachya* have been found rarely in field crops (Szotkowski, 1981; Guzik and Sudnik-Wójcikowska, 1997; Poscher, 1997). However, none of *Ambrosia* species found extensive habitats to become widely distributed in Poland (Poscher, 1997). The most numerous is *A. artemisiifolia.* In the period 1873 – 1997 about 100 foci of this species were found in Poland. *Ambrosia psilostachya* and *A. trifida* are very rare. For instance, in the period 1900-1997 only about 25 foci of *A. psilostachya* and about 20 foci of *A. trifida* were found (Guzik and Sudnik-Wójcikowska, 1997). Plants of the genus *Ambrosia* have been causing no economic damage in Poland, so far (Poscher, 1997). These species occur also in areas adjoining to the PRA area, especially in countries of the former Soviet Union and Hungary (Berés and Hunyadi, 1980; Savotikov and Smetnik, 1995).

3.2. World distribution of the pests

All above-mentioned species are widespread in North America (Frankton and Mulligan, 1970; Bassett and Crompton, 1975), and from there they have been spread into other continents. Their present distribution is the following (Savotikov and Smetnik, 1995; Poscher, 1997):

Ambrosia artemisiifolia

Europe: Austria, Azerbaijan, the Czech Republic, Belgium, France, Germany, Hungary, Italy, Moldova, Poland, Portugal, Russia, Slovakia, Sweden, Switzerland, Ukraine, United Kingdom and Yugoslavia.
Asia: Japan, Korea and Kazakhstan.
North and Central America: Canada, Cuba, Guadeloupe, Martinique, Mexico and USA.
South America: Argentina, Bolivia, Chile, Paraguay, Peru and Uruguay.
Oceania: Australia.

Ambrosia psilostachya

Europe: Belgium, Denmark, France, Germany, Hungary, Italy, Moldova, the Netherlands, Poland, Russia, Spain, Switzerland and Ukraine.
North America: Canada and USA.
Oceania: Australia.

Ambrosia trifida

Europe: Belgium, Estonia, France, Germany, Georgia, Italy, Latvia, Lithuania, the Netherlands, Norway, Sweden, Switzerland, Poland, Russia, Ukraine and Yugoslavia.
Asia: Japan and Korea.
North America: Canada, Mexico and USA.

3.3. Area of origin and history of spread

The above-mentioned *Ambrosia* species are native in North America (Frankton and Mulligan, 1970; Bassett and Crompton, 1975). In Canada, pollens of *A. artemisiifolia*, *A. psilostachya* and *A. trifida* were abundant in late-glacial, postglacial and Pleistocene deposits, in most of the pollen profiles (Bassett and Terasmae, 1962). However, these weeds spread to other continents, especially in the Northern Hemisphere. For instance, *A. artemisiifolia* has been recorded as early as in 1838 in Michigan (USA) (Bassett and Crompton, 1975). In 1863 it was found in Germany, in 1875 in France, in 1902 in Italy and in the first decades of 20th century it spread into such countries as Hungary, Yugoslavia, Ukraine and Russia (Kott, 1953; Berés and Hunyadi, 1980; Igrc, 1987; Kovalev, 1989; Lebedeva, 1993). *A. trifida* was spread to Europe in 18th century.

Nedolushko (1984) stated that the present area of distribution of *A. artemisiifolia* in Russia was steady and that during the past 50 years the weed had occupied all regions in this country with more that 150 frost-free days per year. Song-Jung et al. (1998) reconstructed the invasion of *A. artemisiifolia* in the Ukrainian Carpathian Mts. and Transcarpathian Plain in Central Europe. They stated, that the first focus of the weed on this area had been dated from the beginning of the 1940s. Within the next 55-year period, the average distributional spread speed was 67.6 km^2/year. In accordance with the authors, the area occupied by the weed in the region studied is currently about 3716.5 km^2

In many areas in Europe the weeds still continue their expansion. For instance Jehlik (1995) during surveys conducted in 1968 – 1994 at important railway junctions of the Czech Republic found the continuous expansion of *A. artemisiifolia,* which was noticed at 59% of chosen railway stations.

Siconia of *Ambrosia* were introduced into new territories with different commodities originating in North America (Kovalev, 1989). The spread with infested plant material (seeds, grain, fodder) is more probable than the spread by natural means (Guzik, personal comm.).

3.4. Overlap of world distribution of the pests with that of major host crops

Major crops infested by the weeds (cereals, maize, soya beans, sunflower, root crops etc.) are very common in North America, Europe, Japan and Australia, i.e. the areas where *Ambrosia* spp. occur. For instance the area of cereal crops in 1998 was the following: in the USA - 6,2140,000 ha, in Canada - 18,025,000 ha, in Australia - 16,270,000 ha, in Japan - 2,198,000 ha, in Russia - 48,375,000 ha. In the same year the area of maize crops was the following: in the USA - 29,861,000 ha, in Canada - 1,110,000 ha, in Yugoslavia - 1,350,000 ha, in Hungary - 1,055,000 ha. whilst the area of potato crops was the following - in the USA - 556,000 ha, in Canada - 150,000 ha, in Russia - 3,352,000 ha, in Ukraine - 1,580,000 ha (Central Statistical Office, 1999).

Section 4. The crops infested with the weeds

4.1. Crops infested with the pests reported on areas of their present distribution

In areas of their distribution, *Ambrosia* spp. occur in different crops such as cereals (wheat, rye, barley, oat), maize, root crops (sugarbeet, potatoes), soya bean, sunflower, fodder plants, grapes and in orchards, meadows, pastures etc. (Webster et al., 1989; Stefanović and Šinzar, 1993; Savotikov and Smetnik, 1995).

4.2. Host crops occurring in the PRA area

Cereal and root crops are grown on almost whole territory of Poland. The importance of these crops in Poland is very high. In 1998 the area of cereal crops (wheat, rye, barley, oat, triticale and cereal mixtures) was 8,844,000 ha (70.25% of whole area under cultivation), the area of maize for grain was about 85,000 ha (0.67% of whole area under cultivation), the area of maize for fodder purposes was 145,000 ha (1,15% of whole area under cultivation), the area of potatoes was 1,295,000 ha (10,28% of whole area under cultivation) and the area of sugar-beet was 400,000 ha (3.17% of whole area under cultivation). Meadows and pastures are common, too. In 1998 the area of meadows was 2,616,000 ha and the area of pastures was 1,448,000 ha (Central Statistical Office, 1999). The area of sunflower and soybean plantations is small (no detailed data available).

4.3. Nature of the host crops range

Ambrosia artemisiifolia, A. psilostachya and A. trifida may infest wide range of crops growing in the temperate zone (Savotikov and Smetnik, 1995). So, it is likely that *Ambrosia* spp. introduced to different crops of this zone together with plant material could establish there and spread to neighbouring areas.

Section 5. Potential of the pest for establishment in the PRA area

5.1. Climatic conditions for the pest development

Plants of *Ambrosia* spp. prefer temperate, warm continental climate, dryer and warmer than the climate of Poland (Oberdorfer, 1994). The development of these plants is strongly depended on temperature. For instance, after 28 days with temperatures 10, 20, 30 and 40^0C germination of *A. artemisiifolia* was 6.9, 8.6, 8.1 and 0.8% respectively. Alternating temperatures of 10^0C for 16 h and 30^0C for 8 h in 24 h cycle resulted in 75% germination of seeds of this species (Bassett and Crompton, 1975). Dickerson (1968) states that the highest rate of germination was realised when using alternating temperatures 10 – 30^0C. Field conditions in Michigan, USA, where the experiments were conducted are similar to such conditions in Poland. Li (1989) found that in Shenyang, China, the germination temperature optimum was 10 – 20^0C with a minimum of 5^0C and maximum 21^0C. So, it may be stated, that for proper development of this species alternating temperatures of 10 – 30^0C during the spring and early summer are required.

Berés and Sárdi (1998) stated that during laboratory tests that the lowest percentages of germination of seeds of *A. artemisiifolia* had been obtained at a constant temperature of 10^0C and the highest percentages of germination had been obtained at alternating temperatures between 14 and 22^0C, according to the part of the day. These authors also observed that both natural and artificial light condition had a stimulating effect on the germination of seeds.

During cabinet studies conducted in Ontario, Canada, Deen et al. (1998) found that development of *A. artemisiifolia* had occurred over a temperature range of 8.0 – 31.7 ^{0}C. During above mentioned studies this plant species was photoperiod insensitive during its short juvenile phase. Following the juvenile phase, sensitivity to photoperiod was constant and continued until pistillate flowers were observed. Photoperiods of 14 h or less were optimal and resulted in maximum rate of development.

The germination of *A. psilostachya* starts when the soil temperature is 13-15^{0}C. Seeds of *A. trifida* starts to germinate when the soil temperature is 5-6^{0}C, but their best germination is observed under alternating temperatures of 20-30^{0}C (Bassett and Crompton, 1982; Shamonin and Smetnik, 1986).

Plants of the genus *Ambrosia* require full light. So, they grow in sunny and hot places (Oberdorfer, 1994).

The soil moisture is also very important factor. *Ambrosia* spp. prefer dry and fresh soils (Oberdorfer, 1994). For instance, the soil moisture levels from 14 to 22% are required for germination of *A. artemisiifolia* (Dickerson, 1968) and 20-33% for germination of A. *trifida* (Abdul-Fatih and Bazzaz, 1979).

Except of climatic conditions, erosional disturbances such as rain-wash channels or gulleys, and microdisturbances such as soil heaps from the runways of burrowing animals also play an important role in the presence of *A. artemisiifolia* in some areas (Bassett and Crompton, 1975). Curtis and Partch (1948) found that the number plants of *A. artemisiifolia* increased greatly after the burning of grasslands occupied mainly with perennial grasses. They presumed that the increase of the number of these plants probably had come from buried seeds.

The fertility of the soil is also very important factor. Oberdorfer (1994) stated that *Ambrosia* spp. preferred moderately fertile and fertile soils, both scanty and fruitful with humus. During studies conducted in Poland, Krasicka-Korczyńska and Korczyński (1995) found, that the development of *A. psilostachya* was the best on aerated, penetrable and fertile soils. It grew best on abandoned fields, mechanically moved soil and on lawns. Cahil and Casper (1999) found that above ground biomass of individually grown plants of *A. artemisiifolia* was greater when fertilizer (nutrient) was located in a single patch then when the same amount of fertilizer was distributed evenly throughout the soil. Additionally, this species proliferated roots in high-nutrient patches.

5.2. Data on climatic conditions in PRA area

Different authors describe the climate of Poland as a temperate climate, cooler, with mean temperature of the coolest month (January) above -5^{0}C, moderately moist. It is also known as a climate of deciduous forest green in the summer or the climate of the oak (Schmuck, 1959).

Taking into account the isotherms of August in Europe (De Guiran and Boulbria, 1986) it may be noted, that Poland is situated between isotherms of +15^{0}C and +20^{0}C (fig. 4). Between these isotherms also are situated the Hungary and some areas in Ukraine and Russia, where *Ambrosia* spp. are established and have very big economic importance.

In January, 1997 the mean monthly temperature (fig. 5) varied from -6.3^{0}C in Nowy Sącz (southern Poland) to -2.2^{0}C in Świnoujście (northern Poland, in the coast region). In eastern and southern regions of Poland this temperature was about -5^{0}C to -6^{0}C, but in north-western part of the country it varied from about -3^{0}C to -4^{0}C (Instytut Meteorologii i Gospodarki Wodnej, 1997a). In July 1997, the warmest month in the year, the mean monthly temperature of the almost all country fluctuated from 17^{0}C to 18^{0}C (fig. 6). It was the lowest in Jelenia Góra (southwestern Poland) - 15.9^{0}C, and the highest in Puławy (eastern Poland) - 18.5^{0}C (Instytut Meteorologii i Gospodarki Wodnej, 1997b).

In January, 1998 the mean monthly temperature was higher than in January, 1997. It varied from -0.5^{0}C in Kielce (southern Poland) to +3.0^{0}C in Ustka (northern Poland, in the coast region). On the almost all territory of Poland this temperature was about 0^{0}C to +2^{0}C (Instytut Meteorologii i Gospodarki Wodnej, 1998a). In July 1998, the warmest month in the year, the mean monthly temperature fluctuated from 16^0C to 18^0C. It was the lowest in Chojnice (Northern Poland) - 15.7^0C, and the highest in Tarnów (southern Poland) - 18.6^0C (Instytut Meteorologii i Gospodarki Wodnej, 1998c).

In January, 1999 the mean monthly temperature varied from - 2.2^0C in Suwałki (eastern Poland) to $+2.4^0$C in Szczecin (northern Poland, in the coast region). In general, the mean monthly temperature was lower in eastern part of the country than in its western part (Instytut Meteorologii i Gospodarki Wodnej, 1999a). During the first decade of July 1999, the warmest month in the year, the temperature fluctuated from 19^0C, to 21.8^0C. However, during second and third decades the mean temperature was slightly lower and varied from 19^0C to 21^0C in the period of the second decade and from 17.6^0C to 19.9 ^{0}C in the period of the third decade (Instytut Meteorologii i Gospodarki Wodnej, 1999b).

During the first decade of January, 2000 the mean temperature varied from $–2.1^0$C to 3.4 ^{0}C. However, during second and third decades the mean temperature was lower and varied from – 3.2 ^{0}C to 0.8^0C in the period of the second decade and from $–4.3^0$C to $–0.1^0$C in the period of the third decade (Instytut Meteorologii i Gospodarki Wodnej, 2000a).

Very important for the weed development is the mean monthly temperature in April, when *Ambrosia* spp. usually starts to develop. In April, 1998 (fig. 7) the mean monthly temperature varied from 8.2^0C in Ustka (northern Poland, in the coast region) to 11.1^0C in Opole and Tarnów (southern Poland). On the almost all territory of Poland this temperature was about 6^0C to 8^0C (fig. 7) (Instytut Meteorologii i Gospodarki Wodnej, 1998b). During the first decade of April 2000 the mean temperature was the lowest and varied from 4.9^0C to 6.6^0C. However, during second and third decades the temperature was higher and varied from 9.7^0C to 13.6^0C in the period of the second decade and from 15.9^0C to 19.0^0C in the period of the third decade (Instytut Meteorologii i Gospodarki Wodnej, 2000b).

The mean temperature of the year, except of highest parts of the mountains fluctuated from 5.7^0C to 9.0^0C in 1995 and from 5.9^0C to 9.3^0C in 1998. In the period 1981-1998 the minimal temperature was -35.4^0C and the maximal temperature was 37.8^0C (Central Statistical Office, 1999).

However, it may be stated that during spring and early summer alternating temperatures of 10 – 30^0C are often achieved, but it differs each year. The sum of effective temperatures during growing season (above 10^0C) for Skierniewice (central Poland) in the period 1979 – 1998 varied from 689.0 ^{0}C in 1980 to 1200.9 ^{0}C in 1992 (unpublished data of meteorological station of the Institute of Horticulture and Floriculture in Skierniewice).

Precipitation in Poland is the highest in the mountains (southern part of the country). For instance, in 1991 – 1995 it was 1071 mm in Śnieżka mountain (Beskidy Mountains) and 989 mm in Zakopane (Tatra Mountains). In 1998 it was 1243 mm in Śnieżka mountain (Beskidy Mountains) and 1126 mm in Zakopane (Tatra Mountains) and 1115 in Bielsko-Biała (southern Poland). In both uplands and lowlands precipitation was lower. In 1991 – 1995 it varied from 395 – 734 mm and in 1998 from 470 – 1010 mm (Central Statistical Office, 1999).

Section 6. Control of the pests

6.1. Control measures in regular use

The pests are controlled using techniques of field-crop production, mechanical, chemical and biological methods.

In Russia for the control of *Ambrosia* are recommended some techniques of field-crop production such as proper crop rotation, tillage system, and cultivation of plants causing decrease of the number of seeds of the weeds and making impossible the re-contamination of the fields with siconia of this weed (Savotikov and Smetnik, 1995). Gebben (1965) implies that agricultural techniques, with modern equipment applied to row crops kills seeds of many weeds, in it seeds of *A. artemisiifolia*. For instance, the harrow made in proper time may destroy 80% of young plants (seedlings) of *A. artemisiifolia* (Shamonin and Smetnik, 1986).

Digging out and burning of plants before flowering may destroy small foci of the weeds, especially these of perennial species. Control of perennial *Ambrosia* species with mechanical means is more difficult. However, continuous cutting of plants during the summer months is necessary to prevent flowering and subsequent seed development. This practice must be carried out for several years to eradicate the plant clones through starving the spreading rootstocks (Bassett and Crompton, 1975).

During experiments conducted in Northern Poland, Miziniak, Praczyk and Banaszak (2001) found that drying of rootstocks of *A. psilostachya* and their covering with thick soil layer affected their survival. For instance, the authors observed death of rootstocks, which during drying had lost 58% of their mass or had been covered with 25-cm soil layer.

Ambrosia spp. may be controlled with different herbicides. For instance, in Canada *A. artemisiifolia* has been effectively controlled by spraying in summer months with 2,4 D, 2,4,5-T, MCPA, Fenoprop, Mecoprop, 2,4 D B or MCPB (Bassett and Crompton, 1975), while *A. trifida* has been effectively controlled by one application of 2,4 D, 2,4,5-T, MCPA, Fenoprop, Mecoprop, or 2,4 D-B (Bassett and Crompton, 1975). In Nebraska, USA, *A. psilostachya* has been effectively controlled in pastures with Picloram, Dicamba and 2.4 D (McCarty and Scifres, 1972.

In the USA Ackley et al.(1996) observed satisfactory control of *A. artemisiifolia* in potato with rimsulfuron (35 g/ha) mixed with metrabuzin (280 g/ha). When the herbicides were applied before potato or weed emergence they controlled *A. artemisiifolia* 78% and 90% in 1992 and 1993 respectively. Where the herbicides were applied to actively growing weeds, the efficacy of the control of *A. artemisiifolia* was 93% in both years.

In Russia *A. artemisiifolia* is controlled with the following herbicides: in wheat crops - 2,4 DA and Lontrel; in maize and sorghum crops - Erdicane, Simazin and Mayazin; in sunflower crops – Dual and Eptam; in sugar beet crops - Betanal AM and Benzar; in tomato crops - Treflane; in lucerne crops - Pivot; in orchards and vineyards - Roundup, in uncultivated areas – Roundup and Arsenal (Savotikov and Smetnik, 1995).

In Yugoslavia (Serbia) in maize crops *A. artemisiifolia* may be controlled with the following herbicides: prometrin, cinazin, bentazon, 2,4 D + MCPA, fluorochloridon, 2,4-D, dicamba, vernolat, tifensulforon-methyl and primisulforon-methyl (Stefanović and Šinzar, 1993).

Weeds of the genus *Ambrosia* are resistant for many herbicides. For instance, in the former Yugoslavia because of a lack of efficiency of some herbicides against *A. artemisiifolia* even total damage of some crops was found. In this country populations of *A. artemisiifolia* very resistant to atrazine were found near the factory which produces atrazine (Igrc, 1987).

In Austria *A. artemisiifolia* is satisfactory controlled in maize crops with: dicamba (Mais-Banvel), primsulfuron (Tell WG 75), terbulylazin (Gardoprim 500 FW) as well as mixtures of herbicides tetrabutylazin + bromfenoxim (Faneron multi 500 flüssig) and tetrabutylazin + pyridate (Lido SC) (Hain and Klug, 1997).

Berés (1995) stated, that in Hungary at the 2-4 leaves' phenological stage of *A. artemisiifolia* the following herbicides gave 100% control of *A. artemisiifolia*: paraquat-dichlorid (Gramoxone), glyphosate (Glialka 20 EC), acifluorfen (Blazer 2 S) and MCPA (Dikotex 40 EC). At 4-6 leaves' stage of this weed effective were the following herbicides: acifluorfen (Blazer 2 S), MCPA (Dikotex 40 EC), glufosinat-ammonium (Finale), triasulfuron+fluoroglykofen (Satis 15 WG), biophenox (Modown 4 F) and fluoroxpyr (Starane).

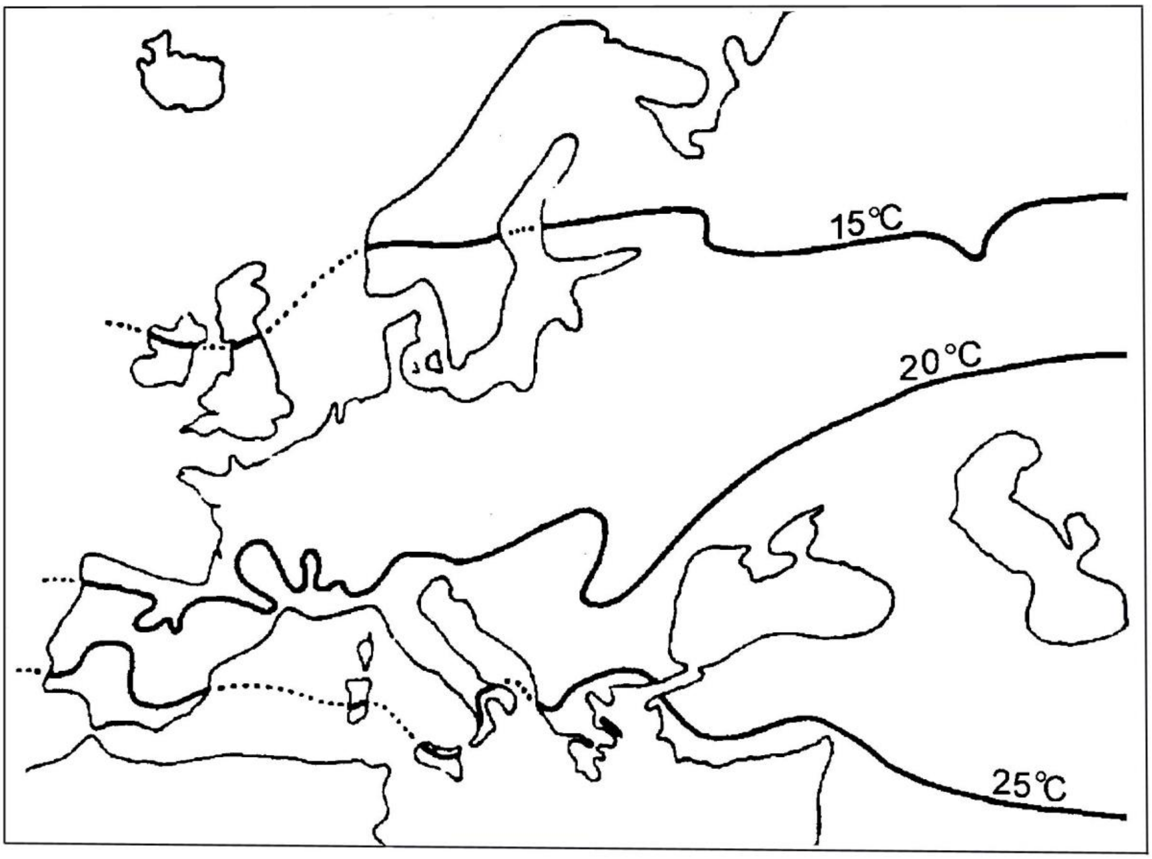

Fig. 4. Mean August isotherms in Europe (from De Guiran and Boulbria, 1986).

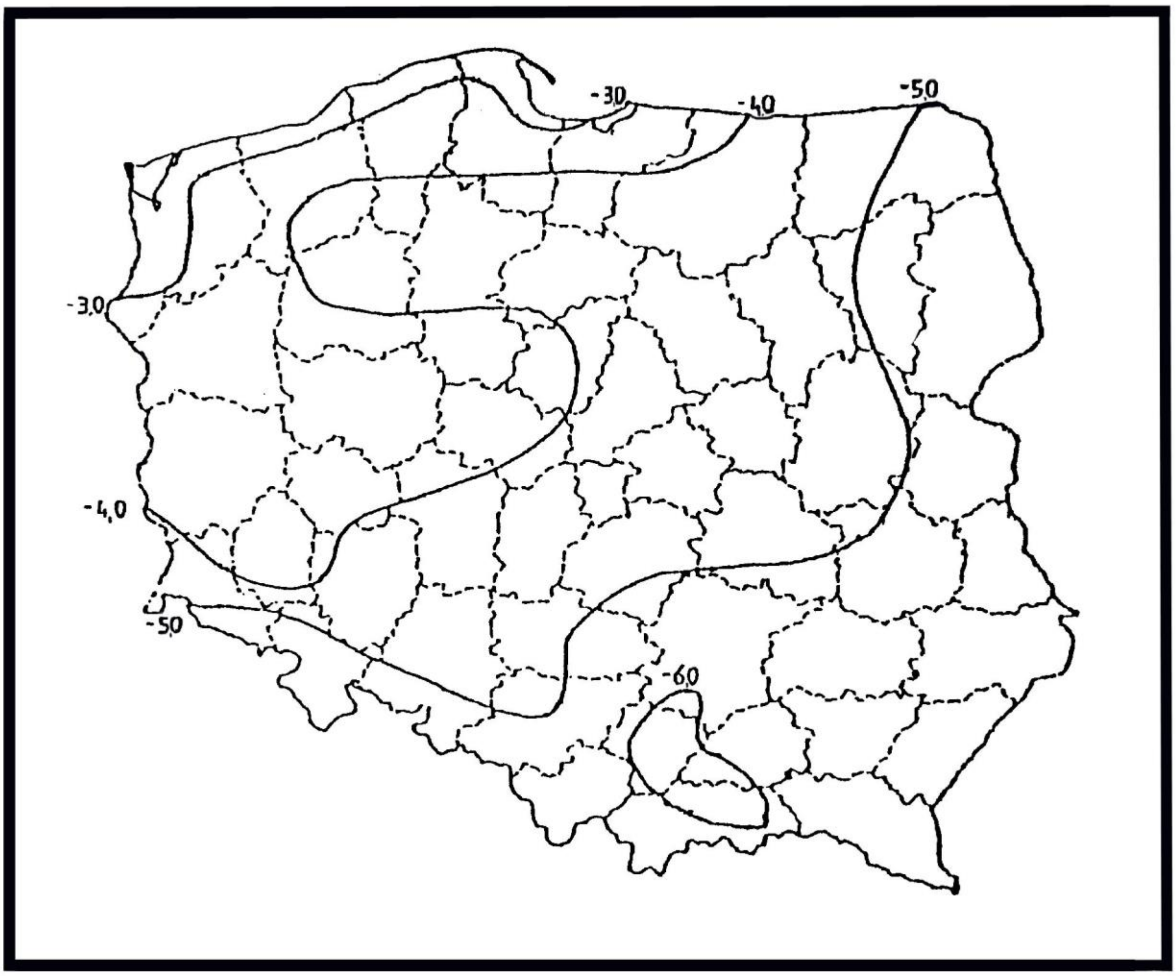

Fig. 5. Mean isotherms in January, 1997 in Poland - data from the Institute of Meteorology and Water Economy (Instytut Meteorologii i Gospodarki Wodnej, 1997a).

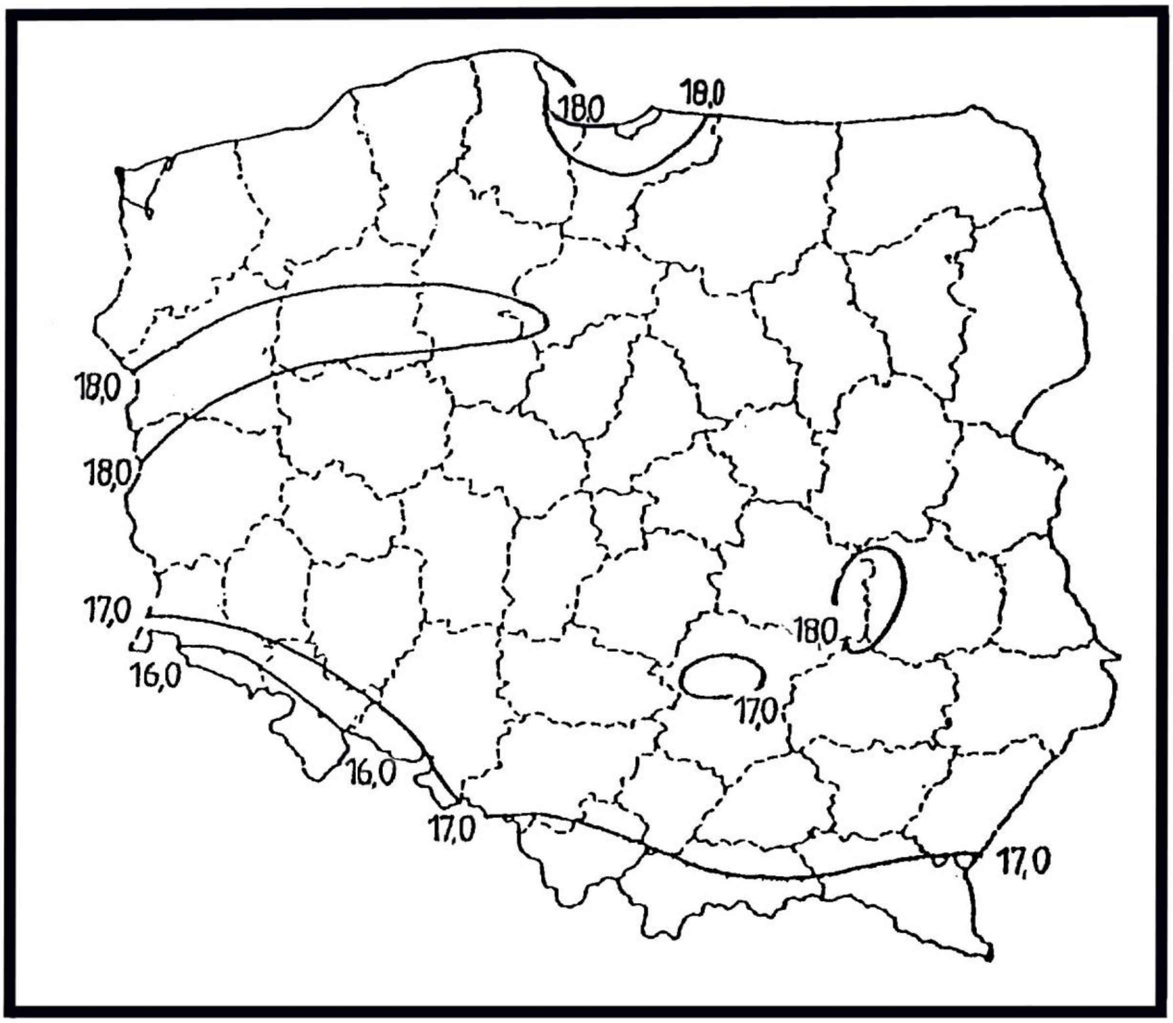

Fig. 6. Mean isotherms in July, 1997 in Poland - data from the Institute of Meteorology and Water Economy (Instytut Meteorologii i Gospodarki Wodnej, 1997b).

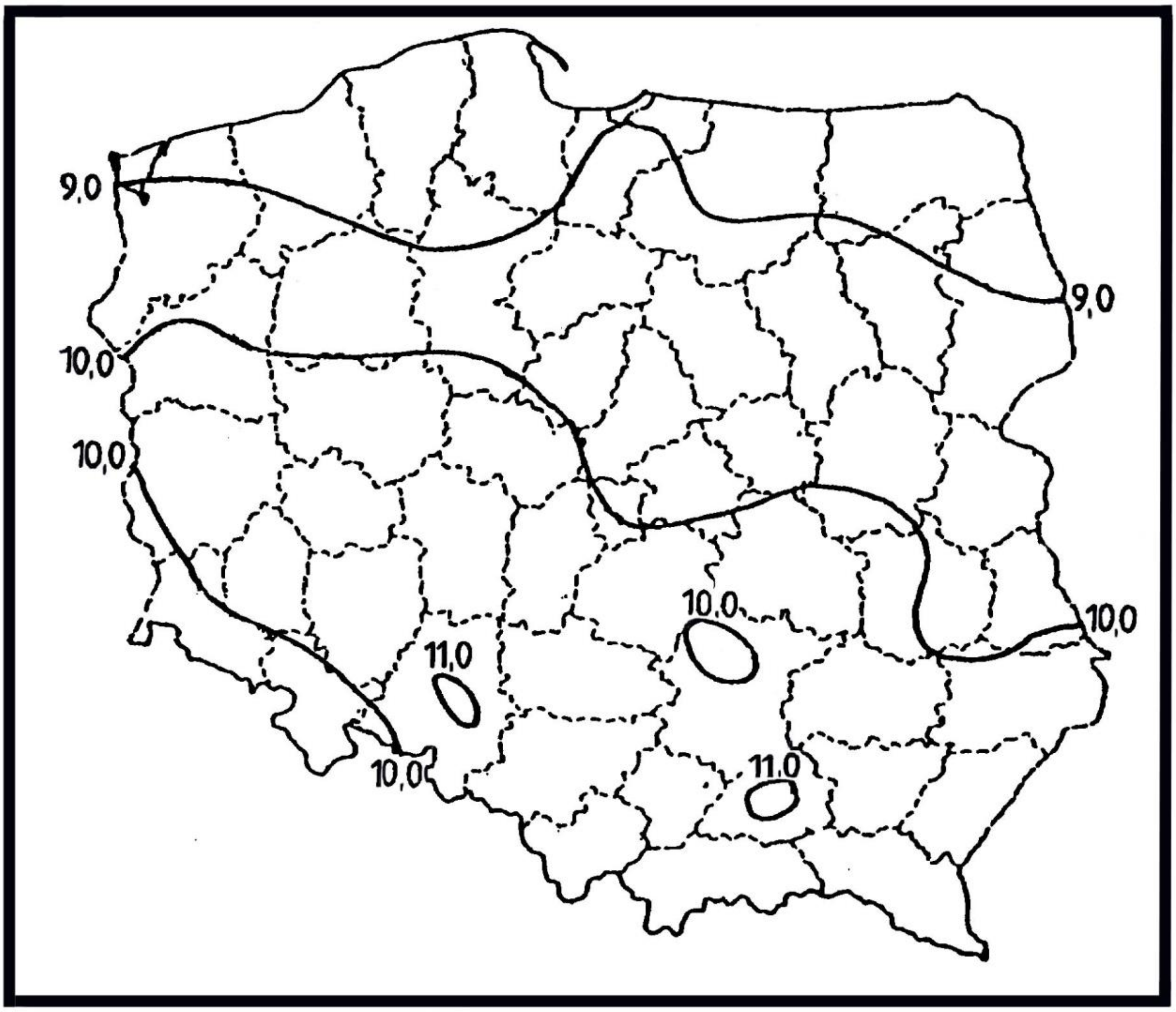

Fig. 7. Mean isotherms in April, 1998 in Poland - data from the Institute of Meteorology and Water Economy (Instytut Meteorologii i Gospodarki Wodnej, 1998b).

During experiments conducted in France it was found that phenologies of sunflowers and *A. artemisiifolia* were similar and thus few products selective in sunflowers were effective against this weed. The best control of *A. artemisiifolia* in sunflower crop and the least damage of this crop were obtained were the treatments with trifluralin before planting or with metolachlor followed pre-emergence flurochloridone incorporation were conducted (Chollet et al., 1998).

During experiments conducted in Poland by Dr. Heliodor Banaszak and MSc. Wojciech Miziniak (Institute of Plant Protection, Regional Experimental Station in Toruń), concerning the control of *A. psilostachya* in oat crop in Grodno near Chełmża (Bydgoszcz voivodeship, northern Poland), thirteen herbicides were used for control of this weed. During those experiments the highest doses of all the herbicides recommended for use for crop protection in Poland and the doses twice as large were used. The most effective were herbicides Gesaprim 500 SC (3-6 l/ha) /recommended dose 3 l/ha/ and Garlon 480 EC (6 l/ha) /recommended doses 2-4 l/ha/, which caused total inhibition of the development of the weed after a lapse of about 2 months after the treatment. Highly effective were also the following herbicides: Casaron G (120 kg/ha), Garlon 480 ECX(4 l/ha), Pyramin Turbo 520 EC (14 l/ha), Lontrel 300 (0,8 l/ha) and Roundup Ultra 360 SL (5 l/ha). More effective were treatments conducted at earlier growth stage (the phase of 4-6 leaves) than at the beginning of florescence. Unfortunately, all herbicides used in above mentioned doses caused destruction of oat plants. The only herbicide applied during experiment, recommended for weed control in oat crops was Chwastox extra 300 SL (recommended dose 2.5-3 l/ha). During experiments doses of 3.5 and 7 l/ha were used. This herbicide applied at the phase of 4-6 leaves and at the beginning of florescence destroyed 11.6 and 63.3% of the weed plants respectively, where the dose of 3.5 l/ha was applied, and 40.0 and 73.3% of the weed plants respectively, where the dose of 7.0 l/ha was used. In the autumn, 133 days after the treatment, single aerial shoots of the weed started to emerge. It took place after treatments with all herbicides, even such which initial efficiency of control of *A. psilostachya* was 100%. These results indicate that no herbicide caused permanent control of this weed (Miziniak and Banaszak, 1998).

Specialists of the Voivodeship Inspectorate of Plant Protection in Bydgoszcz conducted experiments on the control of *A. psilostachya* on ruderal places on the territory of the city of Bydgoszcz and its near vicinity (northern Poland). The following herbicides were used: Starane 250 SL (2 l/ha), Roundup 360 SL (6 l/ha) and Garlon 480 EC (2,5 l/ha). The treatments were conducted in the period 3 September – 1 October 1997. The most effective was Roundup 360 SL. In May, 1998 at places treated with above-mentioned herbicides emergence of aerial shoots of *A. psilostachya* was observed (unpublished data).

Specialists of the former Voivodeship Inspectorate of Plant Protection in Toruń conducted experiments on the control of *A. psilostachya* on ruderal place (the dam) at the village Grabowo near Chełmno (Bydgoszcz voivodeship, northern Poland). The first treatment, with Roundup 360 SL (concentration 2.5%) was conducted on 4 June, 1998. After four days no destruction of weed plants was observed. In June/July 1998 the treatments with Starane 250 SL (concentration 1.5%) were conducted. On 13 July all treated weed plants dried up and no emergence of aerial shoots was observed. However, on 27 August at places where the treatment was conducted, the emergence of a few aerial shoots of *A. psilostachya* was found (unpublished data). On 16 September, 1998 the treatment with Atut 100 EC (250 ml/3l of water) was conducted. Three weeks after the treatment no emerging shoots of the weed were found.

Results of above mentioned experiments concerning chemical control of *A. psilostachya* indicate that this control is rather ineffective, because some aerial shoots of this weed usually emerge after the treatment.

So, very important role may play biological control of *Ambrosia* spp. *A. artemisiifolia* meets the criteria established by Harris (1971) and is deemed by him to be a plant suitable for biological control. A lot of parasites has been found on *Ambrosia* spp. in North America. Harris and Piper (1970) listed 217 taxa of arthropods as occurring on these weeds. Also many parasitic fungi have been found in North American *Ambrosia* spp. (Bassett and Crompton, 1975).

The following parasitic (phytophagous) arthropods have been introduced to the former USSR from California to control the weeds: *Tarachidia candefacta* Hübner (Lepidoptera: Noctuidae), *Coleophora* sp. (Lepidoptera: Coleophoridae), *Eriophyes boycei* Keifer (Bassett and Crompton, 1975) and *Zygogramma satularis* (Coleoptera: Chrysomelidae) (Kovalev, 1981).

During surveys carried out in the former Yugoslavia, 28 insect species were recorded feeding on *A. artemisiifolia*. Unfortunately, these species can not be used for biological control of the weeds. Some of them are serious pests of agricultural crops while others are polyphagous, and are likely to attack also crop plants. So, the plant protection authorities of this country decided to start experiment with *Zygogramma satularis* (Maceljski and Igrc, 1989). During investigations conducted in Croatia it was found that among 127 plant species this beetle strongly preferred *A. artemisiifolia*, its only potential host plant (Igrc and Ilovai, 1996).

In Hungary the possibility of control of *A. artemisiifolia* var. *elatior* with some fungi was examined by Bohar (1996) as well as Bohar and Vajna (1996). The following fungi were examined: *Albugo tragopogonis, Macrophomina phaseolina, Plasmopara halstedii, Puccinia conoclinii, Puccinia xanthii* and *Rhizoctonia solani*. The authors states, that the most obvious possibility of biological control of this weed would be introduction to Hungary of the potential biocontrol agent - *Puccinia xanthii.* In autumn, 1998, the natural infestation of *A. artemisiifolia* with the fungus *Sclerotinia sclerotorum* was observed in Hungary (Bohar and Kiss, 1999).

Eardley (1944) suggested using of alternative methods of control of *A. psilostachya* - the competition between the weed and the cultivated plant, such as alfalfa, and frequent cultivation of soil to keep the land without green shoots. However, these methods were elaborated on the basis of experiences with other perennial weeds but not with *A. psilostachya.*

Very important measure is also careful examination of all consignments of plant material being in international trade such as seeds, grain of cereals, maize and soya bean, fodder, for the presence of siconia of *Ambrosia* spp. Each lot of the material contaminated with the weeds should be cleaned before use (sowing, processing) and the waste after cleaning should be destroyed (burnt).

6.2. Records of eradication of the pests

Despite of intensive control measures, there is no record of successful eradication program of the weeds from any infested places. For instance, in the USA *Ambrosia* spp. are still the serious weeds (Webster et al., 1989). The introduction of *A. artemisiifolia* var. *elatior* to Hungary took place in first decades of 20th century, and this weed has not been eradicated from the territory of this country, so far (Berés and Hunyadi, 1980).

Section 7. Transport of the pests

7.1. Methods of natural spread elsewhere in the world

Siconia of the weeds may be spread by water (during heavy rains, floods, by rivers, channels etc.), wind and animals (Shamonin and Smetnik, 1986; Savotikov and Smetnik; 1995). *A. psilostachya* may spread for a short distance also by creeping roots.

7.2. Pattern of international trade in the major host plants of the pests

Plant products in which siconia of the weeds may be present (seeds and grain of cereals, maize, soya bean and sunflower, fodder etc.) form a major proportion of the export trade for European countries, Canada and USA Big quantities of these products are imported into Poland each year. For instance in 1998 this country imported 5,406.33 t of cereal seeds, 319,339.84 t of the grain of cereals and 1,916,968.34 t of the fodder material, including meals (Main Inspectorate of Plant Protection, unpublished data).

7.3. Records of interception of the pests

Siconia of *Ambrosia* spp. have been often intercepted in different plant material. Poscher (1997) stated that siconia of *A. trifida* hed been brought to Europe with grains, animal feed and clover seeds from the USA Michalak (1970) stated that siconia of *A. artemisiifolia* had occasionally been introduced to Silesia region (Southern Poland) with consignments of imported cereals. Nedolushko (1984) suggests that siconia of above mentioned species were introduced into the Primorsk Region in the Far East of Russia probably with the wheat grain from the North America.

Officers of the Russian Plant Quarantine Inspection have found siconia of the weeds in the following material:

- *Ambrosia artemisiifolia:* the grain of wheat and maize from the USA, Canada, Argentina and Hungary, the grain of soya bean from the USA, soya meal from Belgium, the Netherlands, Brazil and Germany, seeds of grasses from Hungary;
- *Ambrosia trifida:* the grain of wheat and maize from Canada and the USA, the grain of soya bean from the USA, seeds of grasses from the Netherlands, the grain of rice from Japan; the grain of barley from France and Canada, and in the soya meal from Germany, the Netherlands and Brazil (Shamonin and Smetnik, 1986).

Officers of the Finnish Plant Quarantine Service have found *A. artemisiifolia* and *A. trifida* in the grain of maize, soya bean and rye from North America (Suominen, 1979).

The weeds were also intercepted in many consignments of different plant material imported into Poland:

– the grain of maize and soya bean and the soya meal originating in the USA;
– the grain of soya bean originating in Canada;
– the grain of maize, wheat, triticale, soya bean, broomcorn millet and sunflower and the maize meal originating in Hungary;
– the grain of maize, wheat, barley and sunflower originating in Slovakia;
– the grain of maize, sunflower and broomcorn millet originating in the Czech Republic;
– the grain of maize, wheat, broomcorn millet, rapeseed, white mustard, buckwheat, sunflower and oil plants and the medicinal herbs originating in Ukraine;
– the grain of sunflower originating in Belarus;
– the grain of soya bean originating in the Netherlands and Romania;
– the grain of maize and soya bean originating in Austria;
– the grain of maize originating in France;
– the grain of sunflower and buckwheat originating in Russia;
– the soya meal originating in Germany
– the grain of sunflower originating in Belarus (Karnkowski, 1999; Main Inspectorate of Plant Protection, unpublished data).

7.4. Records of movement of the pests not associated with host plants

There are no records of movements of *Ambrosia* spp. associated with the material other than seeds, grain and fodder.

7.5. Specific pathways for movement of the pest to the PRA area.

Siconia of *Ambrosia* spp. may be introduced to the PRA area especially together with imported plant material originating in areas where the weeds are very numerous. It is important to include all material, even this that has not been found as contaminated with the weeds, so far. Other pathways have far little importance in the international movement of the weeds, but they should not be omitted. The approach of different pathways for the movement of this pest is presented separately in Part B, under the title “Pathway Analysis”.

Section 8. Economic impact of the pest

8.1. Type of damage

Ambrosia spp. are serious noxious plants of various crops. Because of strong development of both aerial and underground parts, the plants of these weeds cause the overgrow of cultivated plants, quick drying and impoverishment of the soil. For instance, *A. artemisiifolia* uptakes 2 times more water (per dry mass) than cultivated plants (Savotikov and Smetnik, 1995).

Severe drying and impoverishment of the soil cause economic losses in plant production. The yield is highly reduced and even its complete lost may be noted (Shamonin and Smetnik, 1986). In the majority of areas of their occurrence, plants of the genus *Ambrosia* are noxious weeds having big economic importance. Such areas are: North America (Canada, USA) (Bassett and Crompton, 1975; Webster et al., 1989), Australia, Russia (Maryushkina and Kovalev, 1989; Savotikov and Smetnik, 1995), Ukraine (Maryushkina and Golovko, 1991), the former Yugoslavia (Igrc, 1987; Stefanović and Šinzar, 1993) and Hungary (Berés and Hunyadi, 1980; Berés, 1994). In Yugoslavia (Serbia) *A. artemisiifolia* is very important weed in maize crops. The infestations with this weed start very quickly after emergence of maize plants (Stefanović and Šinzar, 1993). In Hungary *A. artemisiifolia* is one of the most dangerous weeds of the spring-sown domesticated plants (Berés, 1994). Wax at al. (1981) state that in the North Central States of the USA *A. trifida* may be serious weed in maize, soybeans and other crops. Because of erect, hard stems, plants of *Ambrosia* make difficult the harvest of cereals and another plants with agricultural machines such as combine harvesters.

Berés, Sárdi and Kámán (1998) found that extracts (allelochemicals) of *A. artemisiifolia* had significant inhibitory effect on the germination of the following crops: pea, bean, corn and sunflower.

Dense infestations of the weeds have certain effect on biodiversity of the vegetation. Maryushkina (1991) found that in the steppe zone in Ukraine *A. artemisiifolia* inhibits progressive succession by suppressing both annual and perennial plants, and thus decreasing the species diversity of communities.

The pollen of all plants of the genus *Ambrosia* causes strong allergic diseases. These diseases are known as “hay fever”. Inhabitants of areas where dense populations of the weeds occur in masses suffer "hay fever". But susceptible persons may suffer allergic diseases even on the areas where the density of the weeds is low (Allard, 1943; Bassett, Crompton and Frankton, 1976; Wax et al, 1981; Ostroumov, 1989; Savotikov and Smetnik, 1995). In Budapest, Hungary, where *A. artemisiifolia* var. *elatior* occurs commonly, the proportion of persons affected by “hay fever” caused by this weed increased from 8 – 10% in 1980 to 18 – 20% in 1998 (Tóth, Szabó and Maillet, 1998).

The plants or pollen of *Ambrosia* can also cause dermatitis in sensitive people. Therefore they cause significant problems not only on cultivated, but on inhabited areas, too (Frankton and Mulligan, 1970; Tóth, Szabó and Maillet, 1998). Ragweed oil dermatitis was described by Fromer and Burrage (1953). These authors state that in the USA it is a seasonal dermatitis occurring from early August to the first frost, commonly affecting male outdoor workers over 40 years of age.

In Poland, Obtulowicz et al. (1995) found that in Cracow (southern Poland) the number of pollen grains of *Ambrosia* in air was low. However, during tests conducted by these authors it was found, that 42% of the persons susceptible to allergic diseases had shown positive allergic skin reaction after the treatment of their skin with extract of *A. artemisiifolia*.

8.2. Recorded economic impact

The prevalence of *Ambrosia* spp. in different crops is well known, but precise values of losses are difficult if not impossible to estimate (Dickerson, 1968). However, it was found that in Missouri, U.S.A two plants of *A. trifida* per 9 m of row caused reduction of soya bean seed yield 46 – 50% and a density of 16 plants per 9 m of row caused reduction of yield 92% and 85 % in two successive years (Baysinger and Sims, 1991). Webster et al. (1994) found, that in Ohio, USA, only one plant of *A. trifida* per $1m^2$ reduced soya bean seed yield 45% and 77% in two successive years. In the former Yugoslavia, losses of the yield of the grain of maize of 20 – 80% were observed (Igrc, 1987). The mean reduction of the yield of cereal crops caused by the weeds in the areas of numerous occurrence of *Ambrosia* spp. comes up to 15 – 18% (Adamczewski, personal comm.)

8.3. Estimated effect of the presence of the pest of exported commodities

Patterns of trade are subject to both market conditions and phytosanitary requirements. Requirement of importation to Poland of plant material free of siconia *Ambrosia* spp. only, could reduce the volumes of trade of grain of maize and soya bean from countries where the weeds are very numerous. If the introduction of contaminated material is allowed, the expensive cleaning of it will be required. In such a case the second problem would be destroying of the waste after cleaning which contains siconia of *Ambrosia* spp.

If the weeds establish in crops of the PRA area, internal plant quarantine measures are likely to be introduced. These would increase costs of both the producers and, ultimately, the consumers. There would also be restriction on trade to other countries, where *Ambrosia* spp. are listed as quarantine pests.

8.4. Costs and side effects of control measures.

Because of difficulties with the control of *Ambrosia* spp., the farmers would have to cover additional costs of the control measures. The costs depend on the number of the weeds observed, the size of infested area and the kind of herbicide used. So it is practically impossible to evaluate them. However, Webster et al. (1994) estimated that at the density of only 1 plant of *A. trifida* per $1m^2$ of soya bean crop, chemical control of this weed would cost a farmer $41/ha to apply.

Chemical methods of control could affect other plants, the biodiversity of plant populations etc. The residues of pesticides in plants, soil etc. could also be harmful for people and animals.

PART B. PATHWAY ANALYSIS

Siconia of plants of the genus *Ambrosia* may be carried with imported sowing material and the grain of cereals, maize, soya bean, sunflower as well as with products of their processing, especially soya meal. It is possible to transport these weeds with packages, means of transport and by natural means.

The discussion refers to comparison between different pathways and not, at this stage, to finite probability of introduction and establishment.

Individual pathways

Sowing material

Sowing material contaminated with siconia of *Ambrosia* is highly likely to spread the weeds. Siconia usually are not affected during transport of the sowing material. So they could germinate in the fields where this material has been sown and cause heavy infestation of these fields.

Grain for processing

The probability of the spread of *Ambrosia* spp. with the grain of cereals, maize, soya bean, sunflower etc. for processing (the material for consumption, fodder and oil production etc.) is lower than in case of the sowing material, but still high. During transport and re-loading of such a material contaminated with the weeds, the siconia may be introduced into the soil and germinate. If areas of the occurrence of the weeds are not away from crop fields, the weeds could spread into these fields. In Poland specimens of *Ambrosia* plants have often been found on areas near factories processing of imported plant material contaminated with these weeds (Tacik 1971; Krasicka-Korczyńska and Korczyński, 1995; Guzik, personal comm.). For instance, dense infestation with *A. artemisiifolia* was found at the re-loading place near warehouse in Tarnowskie Góry (southern Poland, the Upper Silesia region) and near the feed mill in Sandomierz (southern Poland). In both places maize for processing imported from the USA was stored a few years ago. This maize was slightly contaminated with *A. artemisiifolia*. The entrance of such consignments to Poland was allowed on the basis of the weed seed protocol allowing *Ambrosia* weed seed tolerance in cargoes originating in the USA. Plants of *Ambrosia artemisiifolia* were observed also at place of re-loading of such a maize grain in Podsęków (eastern Poland) and Zebrzydowice (southern Poland, near the border among Poland and the Czech Republic), where very big quantities of the imported plant material are re-loaded. No crop fields are situated in the nearest vicinity of warehouses, so the spread of *Ambrosia* to such fields has not been observed. However, despite intensive control measures emergence of *Ambrosia* plants is still observed at above-mentioned places.

Very interesting case was observed in Starzawa (in southeastern part of Poland, near the border among Poland and Ukraine). A few years ago plants of *Ambrosia artemisiifolia* were found on ruderal places in this village. Probably the weeds were spread by natural means from the border region of Ukraine, causing dense infestation of crop fields and on ruderal places (Starzawa is situated about 1 km away from the border, only). Despite the fact of very intensive control measures the weeds was introduced from the ruderal places into a few maize and cereal crops. The emergence of *Ambrosia* was noticed during the spring 1999. So, it is still under official control.

Above mentioned examples indicate, that contaminated material for processing present a risk of *Ambrosia* to various ruderal places, from which they may spread to crop fields.

Meals for fodder production

The risk of dispersal of *Ambrosia* spp. siconia together with meals for fodder production, such as maize meal and soya bean meal depends on the method of processing. If the grain of maize is granulated into very small particles, these siconia are usually completely destroyed. If these particles are bigger, the probability of damaging of these siconia is lower. During border phytosanitary control of soya bean meal imported to Poland from the USA, undamaged and almost undamaged siconia of *A. trifida* has been found (unpublished data of the Main Inspectorate of Plant Protection). These siconia are likely to germinate.

Spread on clothes, shoes, packages, machinery etc.

The spread of siconia of *Ambrosia* spp. on clothes, shoes, packages, machinery etc. is possible but in available literature no data concerning it importance has been found. However, it probably plays minor role in dispersal of the weeds.

Spread by natural means

The assessment of the role, which plays the spread of siconia of the weeds by natural means, is very difficult. It is known that they may be spread by water (during heavy rains, floods, by rivers, channels), wind and animals (Shamonin and Smetnik, 1986; Savotikov and Smetnik; 1995), but in available literature no details concerning importance of this pathway have been found. However, Dickerson (1968) found that the wind plays minor role in the dispersal of *A. artemisiifolia* because no siconia were found beyond 2 m from experimental plants.

A. psilostachya may spread also by creeping roots. But the distance of such a spread is very short.

Factors affecting entry to pathways and transfer to the PRA area

Entry to pathway

The likelihood of entry of the weeds into any pathways is greatest in areas of their numerous occurrence. In such areas Ambrosia spp. may be common in different crops. During the harvest siconia of the weeds may be introduced into the crops.

The severity of infestation of different crops depends on many factors: such as proper climatic and soil conditions, number of seeds of the weeds in the soil, cultivated plant species, tillage methods used, control measures etc. and that is why it is generally not predictable. However, the big volume of potentially infested material imported to Poland still results in large number of contaminated consignments.

The wide distribution of *Ambrosia* spp. in North America and very numerous interceptions of consignments infested with these pests indicates that there is probably no region where maize and soya bean crops may be regarded as free of these weeds (see Part A, Paragraphs 3 and 6). So, the entry of siconia of the weeds into consignments intended for export is very likely.

Transfer from pathway to crop fields in the PRA area

Different factors will influence the likelihood of transfer and successful establishment of *Ambrosia* in Polish crop fields. If siconia of the weeds are present in the sowing material they could spread directly to crop fields in Poland and establish in these fields. Climatic conditions probably would be favourable for establishment of the weeds (see Part A, Section 6). If siconia of the weeds are present in grain for processing, the probability of transfer and establishment of the weeds depends on the kind of material, the distance of warehouses and places of re-loading of this material from crop fields etc. If mills or oil seeds processing factories are situated near crop fields, siconia are likely to be introduced into these fields.

The transfer of siconia from clothes, shoes, packages, machinery etc. is more likely when men wearing contaminated clothes work in crop fields as well as contaminated machinery or packages are used in these fields.

C. PEST RISK ASSESSMENT

STAGE 1 - Initiation of the PRA process

Pest identification

The subjects of the analysis are weeds belonging to the genus *Ambrosia*, mainly: *Ambrosia artemisiifolia*, *A. trifida* and *A. psilostachya.* Each of these species has well-defined taxonomic position.

Siconia of plants from the genus *Ambrosia* may be introduced into the territory of the Republic of Poland together with imported sowing material, the grain of cereals, maize (*Zea mays*), soya bean (*Glycine max*), sunflower (*Helianthus annuus*) and products of their processing, especially soya meal.

The PRA process was initiated by the pests, which have been intercepted many times in imported plant material:

- the grain of maize and soya bean and the soya meal originating in the USA;
- the grain of soya bean originating in Canada;
- the grain of maize, wheat, triticale, soya bean, broomcorn millet and sunflower and the maize meal originating in Hungary;
- the grain of maize, wheat, barley and sunflower originating in Slovakia;
- the grain of maize, sunflower and broomcorn millet originating in the Czech Republic;
- the grain of maize, wheat, broomcorn millet, rapeseed, white mustard, buckwheat, sunflower and oil plants and the medicinal herbs originating in Ukraine;
- the grain of sunflower originating in Belarus;
- the grain of soya bean originating in the Netherlands and Romania;
- the grain of maize and soya bean originating in Austria;
- the grain of maize originating in France;
- the grain of sunflower and buckwheat originating in Russia;
- the soya meal originating in Germany
- the grain of sunflower originating in Belarus.

The previous decision allowing the conditional importation of contaminated grain and its industrial processing to the fodder under quarantine supervision was changed.

The PRA area

The PRA area is the territory of the Republic of Poland.

Earlier analysis

Pests of the genus *Ambrosia* have been earlier subjected to the Pest Risk Analysis from the point of view of threat for plant health in Poland, taking into account the definition of the pest contained in the IPPC. This analysis has indicated the risk and has caused inserting of the pests into "The list of harmful organisms subject to compulsory control".

STAGE 2 - Pest Risk Assessment

A. Qualitative criteria of a quarantine pest.

Plants of the genus *Ambrosia* occur in Poland. In general, their distribution is limited to ruderal places, waste lands, lawns, places near roads, railway tracks, stores, surroundings of oil mill and grain processing factories, fodder industry factories based on the commodities imported from the USA. *A. artemisiifolia* and *A. psilostachya* were rarely found in field crops

In the PRA area 32 foci of *Ambrosia* spp. have been found in 1997, 12 foci in 1998, 6 foci in 1999 and 13 foci in 2000. Within their current distribution range plants from the genus *Ambrosia* do not cause any economic losses in the PRA area. Taking into account climatic factors and structure of crops in Poland the pests are likely to cause economic losses in the PRA area. They are likely to cause losses in agricultural production, export of agricultural products and negative social effects (causing of allergic diseases). In compliance with above, the pests being the subject of PRA possess a risk to the PRA area.

B. Quantitative evaluation of the pest

1. Probability of introduction

<u>Entry</u>

- as a contamination of plant material being in trade.

1.1. How many pathways could the pests be carried on ? **7**

(few = 1; many = 9)

Siconia of plants of the genus *Ambrosia* may be carried on with imported sowing material and the grain of cereals, maize, soya bean, sunflower as well as with products of their processing, especially soya meal. It is possible to transport these weeds with packages, means of transport and by natural means.

1.2. How likely are the pests to be associated with the pathway at origin ? **7**

(not likely = 1; very likely = 9)

The probability of transportation of weeds with sowing material is very high; the lower probability - with foodstuffs, fodders and material intended for oil mill factories, on packages, means of transport and by natural means.

1.3. Is the concentration of the pests on the pathway at origin likely to be high ? **7**

(not likely = 1; very likely = 9)

Plants of the genus *Ambrosia* are noxious weeds in many countries, especially in the North America and some European countries. In these countries plants of the weeds occur often very frequently. The big quantities of sowing material and the grain of cereals, the maize, soya bean and sunflower grain are imported from these countries into Poland. So, the probability of the occurrence of numerous populations of the weeds at the place of origin is high.

1.4. How likely are the pests to survive existing cultivation and commercial practices**?** **6**

(not likely = 1; very likely = 9)

Numerous lots of imported plant materials are essentially contaminated with siconia of *Ambrosia*. For instance, tens and even more siconia of these weeds were found in 1 kg of the maize and soya bean grain originating in the USA Essentially contaminated lots originating in countries where *Ambrosia* spp. are very numerous. So, it may be recognised that the probability to survive by the weeds existing cultivation and commercial practices is high.

1.5. How likely are the pests to remain undetected during inspection or testing? **4**

(not likely = 1; very likely = 9)

The probability of no detection of the weeds depends on the species of *Ambrosia* and the kind of product. For instance, relatively easily is to detect of big siconia of *Ambrosia trifida***,** while species having smaller siconia as *Ambrosia artemisiifolia* are detected with some difficulty. However, in general there are no major problems with detection of the weeds during border phytosanitary inspection of imported plant material.

1.6. How likely are the pests to survive other existing phytosanitary procedures ? **5**

(not likely = 1; very likely = 9)

Because of relatively high detectability of the weeds, the introduction of their siconia to Poland with consignments of imported plant material is limited in substantial extent. However, cleaning of the contaminated plant material is not fully effective so siconia of the weeds are likely to remain in such a material. On the other hand siconia are quite effective destroyed by milling and grinding of the contaminated material.

1.7. How likely are the pests to survive in transit ? **9**

(not likely = 1; very likely = 9)

Siconia of the weeds do not subject to any harmful influences during transit. That is why in favourable conditions they are likely to germinate causing the fields and other areas infested with the weeds.

1.8. Are the pests likely to multiply during transit ? **1**

(not likely = 1; very likely = 9)

The weeds are not likely to multiply during transit of sowing, consumption, fodder material etc. because of the lack of growing medium and other conditions favourable for germination of seeds and development of plants.

1.9. How large is movement along the pathway ? **8**

(not large = 1; very large = 9)

Big quantities of plant material likely to be contaminated with siconia of *Ambrosia* are imported to Poland each year. For instance in 1998 Poland imported 5,406.33 t of cereal seeds, 319,339.84 t of the grain of cereals and 1,916,968.34 t of the fodder material, including meals.

1.10. How widely is the commodity to be distributed throughout the PRA area ? **8**

(not widely = 1; very widely = 9)

Factories processing the plant material which is likely to be contaminated with *Ambrosia* (mills, fodder industry factories, oil mill factories) are located in the almost whole territory of Poland, only in the mountain area their number is smaller. The sowing material likely to be contaminated with *Ambrosia* may be sown and stored practically in the whole territory of Poland.

1.11. How widely spread in time is the arrival of different consignments ? **8**

(not widely = 1; very widely = 9)

Material for consumption, fodder and oil mill factories is imported practically throughout the whole year. Sowing material is imported mainly in spring and early autumn.

1.12. How likely are the pests to be able to transfer from the pathway to a suitable crop?

- with plant material in trade **8**

(not likely = 1; very likely = 9)

The probability of the transfer of the weeds to suitable crops with sowing material is very high. In case of introduction of the weeds with food-stuffs, fodder and material intended for oil mill factories this probability is smaller, but the weeds are likely to transfer to suitable crops from places near roads, railway tracks, stores etc. So, the possibility of transfer of siconia of *Ambrosia* occurring in imported plant material to suitable crops is likely to be high.

1.13. Is the intended use of the commodity likely to aid introduction ?

- with plant material in trade **8**

(not likely = 1; very likely = 9)

The use of the plant material for sowing aids the introduction of the weeds to crops. However, the use of the plant material for consumption, fodder, processing etc. reduces the probability of such an introduction, but because of frequent location of mills, fodder industry factories, oil mill factories etc. in regions of intensive agricultural production, the threat created by such a material is likely to be high.

<u>Establishment</u>

1.14 How many kinds of crops where the pests could develop are present in the PRA area ? **8**

(**one or few = 1; many = 9)**

The weeds of the genus *Ambrosia* could develop in every kind of cereal crops (wheat, rye, barley, oat) and root crops (sugar-beet, potatoes), plantations of sunflower, maize, meadows and pastures.

1.15. How extensive are the crops where the pests could develop in the PRA area ? **8**
(rare = 1; widespread = 9)
Cereal and root crops occur on almost whole territory of Poland. The importance of these crops in Poland is very high. Meadows and pastures are so common, but sunflower and soybean plantations are not numerous.

1.16 - 1.19. Problems described under these paragraphs do not concern the weeds.

1.20. How similar are the climatic conditions that would affect pests' establishment in the PRA area and in the area of origin ? **7**
(not similar = 1; very similar = 9)
Climatic conditions in Poland are similar to conditions in the area of origin of such species as *Ambrosia artemisiifolia*, *A. psilostachya* and *A. trifida,* i.e. the temperate zone in North America. However, a large number of *Ambrosia* species develop in areas of other climate, for instance in countries of Central and South America. So, climatic conditions of Poland may be recognised as favourable for establishment of above mentioned three species, but little favourable for establishment of the species occurring in subtropical and tropical zones.

1.21. How similar are other abiotic factors in the PRA area and in the area of origin? **7**
(not similar = 1; very similar = 9)
As just as climatic conditions, soil conditions and other abiotic factors in Poland are similar to these in the area of origin of such species as *Ambrosia artemisiifolia*, *A. psilostachya* and *A. trifida,* i.e. the temperate zone in North America. But they are different than these in countries of Central and South America.

1.22. How likely are the pests to have competition from existing species in the PRA area for its ecological niche ? **6**
(very likely = 1; not likely = 9)
In Poland plants of the genus *Ambrosia* are likely to have certain competition to cultivated plants. Greater competition to wild plants would have *A. psilostachya*. Annual species of *Ambrosia,* except of habitations near rivers, probably would have limited competition to wild plants.

1.23. How likely is establishment to be prevented by natural enemies already present in the PRA area ? **7**
(very likely = 1; not likely = 9)
Probably there are no natural enemies of the weeds in Poland. However, infestation of the weeds with parasitic fungi and phytophagous insects occurring in Poland can not be fully excluded. But such an infestation could prevent establishment of the weeds probably in limited range, only.

1.24. If there are differences in the crop environment in the PRA area to that in the area of origin, are they likely to aid establishment? **6**
(very likely = 1; not likely = 9)
There are no fundamental differences in tillage methods in Poland and in the area of origin of the weeds. However, in Poland the big dispersal of farms and smaller mechanisation of agriculture occur, what could make difficult the control of the weeds and aid their establishment.

1.25. Are the control measures, which are already used against other pests during the growing of the crop likely to prevent establishment of the pests ? **5**
(very likely = 1; not likely = 9)

Chemical and mechanical treatments as well as agrotechnical measures used in Poland for control of various weeds are likely to prevent establishment of annual species of *Ambrosia* but they would be little effective against perennial species.

1.26. Is the reproductive strategy of the pests and duration of life cycle likely to aid establishment ? **7**

(not likely = 1; very likely = 9)

Plants of annual species produce very large amount of seeds (for instance one plant of *A. artemisiifolia* produces up 100,000 seeds), while plants of perennial species intensively reproduces vegetatively. Both kinds of reproduction are likely to aid establishment.

1.27. How likely are relatively low populations of the pests to become established ? **8**

(not likely = 1; very likely = 9)

Because of production of numerous mature seeds or intensive vegetative reproduction, under favourable climatic and soil conditions small populations of the weeds are likely to survive and become established in habitats occupied by themselves.

1.28. How probable is that the pest could be eradicated from the PRA area ? **8**

(very likely = 1; not likely = 9)

The eradication of the weeds of the genus *Ambrosia* is very difficult. In some countries, for instance in the USA, despite intensive control measures, the prolonged remaining of population of the weeds is observed. In compliance with above the probability of complete eradication of the weeds from Poland is low.

1.29. How genetically adaptable are the pests ? **8**

(not adaptable = 1; very adaptable = 9)

Species of the genus *Ambrosia* spread from areas of their natural occurrence to countries having different climatic and soil conditions. It attests that the weeds have high genetic abilities to adapt to different conditions.

1.30. How often have the pests been introduced into new areas outside their original range ? **9**

(never = 1; often = 9)

Some *Ambrosia* species, especially *A. artemisiifolia*, *A. psilostachya* and *A. trifida*, originating in North America, widely spread to many countries in Europe and Asia and to Australia, where they often became established, noxious weeds.

2. Economic Impact Assessment

2.1 How important is economic loss caused by the pests within their existing geographic range ? **7**

(little importance = 1; very important = 9)

In the majority of areas of their numerous occurrences, plants of the genus *Ambrosia* are noxious weeds having big economic importance. The reduction of the yield of grain of cereal crops caused by the weeds comes up to 15-18%. Such areas are North America (Canada, USA), Australia, Russia, Ukraine and Hungary.

2.2. How important is environmental damage caused by the pests within their existing geographic range ? **5**

(little importance = 1; very important = 9)

Dense infestations of the weeds have certain effect on biodiversity of the vegetation. If the density of the weeds is low this effect is weak.

2.3. How important is the social damage caused by the pests within their existing geographic range ? **7**

(little importance = 1; very important = 9)

The pollen of all plants of the genus *Ambrosia* causes strong allergic diseases. These diseases are known as "hay fever". Inhabitants of areas where dense populations of the weeds occur in masses suffer "hay fever". But susceptible persons may suffer allergic diseases even on the areas where the density of the weeds is low.

2.4. How extensive is the part of the PRA area likely to suffer damage from the pests? **8**

(very limited = 1; the whole PRA area = 9)

Damage caused by *A. artemesiifolia, A. psilostachya* and *A. trifida* may occur practically on the whole area of Poland. Especially big losses could be expected to occur in regions of warmer climate with continental influences, such as south-eastern Poland and in the Lower Silesia The probability of causing damage by the species originating in warm, dry climate zone is little.

2.5. How rapidly are the pests liable to spread in the PRA area by natural means ? **5**

(very slowly = 1; very rapidly = 9)

Populations of *Ambrosia* spp. usually are limited to places of introduction where they are able to survive and slowly spread. Such a situation is likely to occur in Poland.

2.6. How rapidly are the pests liable to spread in the PRA area by human assistance ? **8**

(very slowly = 1; very rapidly = 9)

The weeds are liable to spread rapidly and over substantial distances by the transport of contaminated plant material. The probability of transportation of the weeds on the clothes and shoes is very low.

2.7. How likely is it that the spread of the pests could be contained within the PRA area ? **8**

(very likely = 1; not likely = 9)

In Poland there are no distinct climatic and environmental barriers, which would be able to prevent the weeds from spreading into another areas.

2.8. Considering the ecological conditions in the PRA area, how serious is the direct effect of the pests on crop yield and/or quality likely to be ? **6**

(not serious = 1; very serious = 9)

In Poland weeds of the genus *Ambrosia* are likely to reduce yields of different crops such as in areas of their mass occurrence. Taking into account the level of cereal grain production in Poland amounts 25 million tonnes, in case of the grain yield reduction by 15-18% (the level of losses caused in the areas of numerous occurrence of *Ambrosia* spp.), the level of the losses would be 4 - 5 million tonnes. Contaminated sowing material would have lower quality. Such a material could be put into trade after accurate cleaning only.

2.9. How likely are the pests to have significant effect on producers profits due to changes in production costs, yields etc. in the PRA area ? **9**

(not likely = 1; very likely = 9)

Dense infestations of the weeds would cause significant reduction of the yield of cultivated plants. Because of difficulties in eradication of the weeds it would be necessary to allocate substantial funds to cover the cost of their chemical and agricultural control. The necessity of cleaning of contaminated seed material would cause the increase of the prices of such a material.

2.10. How likely is the pest to have a significant effect on consumer demand in the PRA area ? **3**

(not likely = 1; very likely = 9)

The consumer uses mainly processed materials, so the weeds probably would have a little effect on consumer demand in Poland. However, because of increase of costs of the production of plant material, for instance the grain of cereals, certain increase of prices of processed materials such flour and bread would occur.

2.11. How likely is the presence of the pests in the PRA area to affect exports markets ? **6**

(not likely = 1; very likely = 9)

Poland exports some products, which are likely to be contaminated with siconia of *Ambrosia* spp., especially cereal grain. Some trade partners of Poland, such as Russia and Ukraine recognise these weeds as quarantine pests. So, above-mentioned countries may prohibit importation of products contaminated with *Ambrosia*.

2.12. How important would other costs resulting from introduction be (e.g. costs of research, advice) ? **8**

(little importance = 1; very important = 9)

In case of the introduction of the weeds it would be necessary to investigate their biology and possibility of their control in different crops, to give the specialist of the Plant Protection Service and the growers appropriate trainings and to prepare appropriate publications and demonstrative materials.

2.13. How important is the environmental damage likely to be in the PRA area ? **5**

(little importance = 1; very important = 9)

Dense infestations of the weeds would have certain effect on biodiversity of the vegetation. If the density of the weeds would be low this effect would be weak.

2.14. How important is the social damage likely to be in the PRA area ? **9**

(little importance = 1; very important = 9)

Such as in areas of very frequent occurrence, the pollen of all plants of the genus *Ambrosia* would cause in Poland strong allergic diseases known as "hay fever". Even on the areas where the density of the weeds is low, susceptible persons would suffer "hay fever". So, the weeds would be the new, potential source of allergy in Poland.

2.15. How probable is that natural enemies, already present in the PRA area, will affect populations of the pest if introduced ? **7**

(very likely = 1; not likely = 9)

Probably there are no natural enemies of the weeds in Poland. However, the possibility of attack of the weeds by parasitic fungi and phytophagous insects occurring in Poland can not be fully excluded.

2.16. How easily can the pests be controlled ? **6**

(easily = 1; very difficulty = 9)

The control of the weeds of the genus *Ambrosia*, especially perennial species, with chemical and technique of field-crop production methods is very difficult. It arises from the possibility of production of numerous seeds by annual species and intensive vegetative propagation of perennial species as well as from their late emergence, florescence and fructification in comparison with cultivated plants.

2.17. How likely are control measures to disrupt existing biological or integrated systems for the control of other pests **?** **2**

(not likely = 1; very likely = 9)

In Poland biological control of weeds has not been used so far. Whereas the influence of the control measures against *Ambrosia* spp. on integrated control of other pests would be low because of limited usage of these methods in field conditions.

2.18. How likely are control measures to have other undesirable side effects ? **2**

(not likely = 1; very likely = 9)

During effective control of weeds from the genus *Ambrosia* with herbicides, the unfavourable influence of used chemicals on cultivated crops, soil fauna, ground-waters etc. could occur. This influence probably would be similar as in case of the control of other weeds and therefore relatively weak.

2.19. Are the pests likely to develop resistance to plant protection products ? **3**

(not likely = 1; very likely = 9)

There has not been recorded immunisation of the weeds against used plant protection products, so far.

3. Final evaluation

Probability of introduction **86 : 13 = 6.61**

Probability of establishment **94 : 13 = 7.23**

Economic impact **114 : 19 = 6.00**

4. Conclusions of the Pest Risk Assessment.

Probability of introduction

The average score obtained - **6.61** indicates that the probability of introduction of weeds of the genus *Ambrosia* is relatively high. Siconia of these weeds may be easily introduced into the PRA area together with plant material (seeds and grain of cereals and maize, grain of soya bean etc.). Big quantities of such a material are imported to Poland each year. Siconia of the weeds can survive transit easily and after dropping into the soil they are likely to germinate causing the fields and other areas infested with the weeds. It is possible even if they are present in plant material for consumption or processing.

Probability of establishment

The average score obtained - **7.23** is relatively high. It indicates that *A. artemisiifolia, A. psilostachya* and *A. trifida* introduced into the PRA area may establish there and develop both on ruderal places and crop fields. Of course, the highest probability of establishment in the crop field occurs in case of introduction of the weeds together with the sowing material. Climatic conditions and other abiotic factors in Poland are similar to these in the area of origin of above mentioned *Ambrosia* species, so they are likely to aid the establishment. Probably there are no natural enemies of the weeds in Poland, which could efficiently prevent the establishment of the weeds.

Economic impact

The average score obtained - **6.00** indicates that the probability of causing economical losses by *A. artemisiifolia, A. psilostachya* and *A. trifida* is relatively high. Dense infestations of crop fields with these weeds could significantly reduce yields. The pollen of all plants of the genus *Ambrosia* would cause strong allergic diseases known as "hay fever". Owners of areas (crop fields, ruderal places etc.) would have to cover costs of eradication of the weeds. The data obtained so far indicate that eradication of *Ambrosia* spp. is difficult, even if the foci is small. Therefore costs of treatment necessary for eradication of these weeds are likely to be high. Siconia of the weeds (especially *A. artemisiifolia* and *A. trifida)* are likely to be spread easily within the PRA area. So, the range of the problem could be wider.

PART D. RISK MANAGEMENT

The PRA concludes with an evaluation of the risk management options to reduce the likelihood of successful transfer of *Ambrosia* spp. to PRA area.

The area of crops, which are likely to be contaminated with *Ambrosia* spp. and the yield of these crops in the PRA area, are very big. Poland also imports the big quantities of plant material, which is likely to be contaminated with siconia of *Ambrosia* spp. (see Part A, paragraph 7.2).

There are numerous risk management options that would provide benefits regardless of which pathway was being considered.

1. Risk management options

Preventive measures in crop fields could be established to obtain the sowing material and grain for processing free of siconia of *Ambrosia* spp. If crop fields are heavily infested with *Ambrosia* spp. the siconia of these weeds may be easily introduced into sowing material and grain destined for trade. So, it is necessary to prevent development of the weeds by making impossible production of the seeds by their plants. It may be achieved using proper mechanical, chemical and agricultural control measures. The weed plants should be destroyed before fructification. The fields infested with *Ambrosia* spp. must not be used for the production of sowing material or grain at least for a few years. The sowing material and the grain destined for export must originate from crops free from *Ambrosia* spp., only.

Option 2. Management during processing

If the infestation of the crop is high, despite intensive control measures, the consignments of plant material may be heavy contaminated with siconia of *Ambrosia* spp. So, other measures have to be used to eliminate this contamination.

Option 2.1. Inspection for siconia to confirm freedom from Ambrosia *spp.*

All of the sowing material, the grain for processing and meals for fodder production should be inspected as carefully as possible. The first inspection should be made after harvest, and the second - before dispatch. These inspections allow forwarding of non-contaminated material only. If given lot is found to be contaminated, it should be subjected to the measures described below.

Option 2.2. Cleaning of the contaminated material

The sowing material and the grain for processing contaminated with siconia of *Ambrosia* spp. may be cleaned (Shamonin and Smetnik, 1986). The method of cleaning used depends on the kind of contaminated plant material and the species of *Ambrosia*. Usually complex cleaning machines using a few various methods are employed. After cleaning the consignment should be sampled and the samples examined for the presence of the siconia. The cleaning should be repeated until no siconia are found in samples.

Experiments carried out by Wachowiak (2000) indicate that cleaning of maize and soya bean grain to remove siconia of *Ambrosia* spp. (these weeds have been very frequently found in such a material) is very difficult and not fully effective. Furthemore, waste material containing siconia of the weeds remains after cleaning. Utilization of big quantities of such a material may be difficult. Wachowiak (2000) found that siconia of *Ambrosia* spp. could be destroyed after a treatment with high temperature 150^{o}C for 30 minutes, alcoholic fermentation or simply combustion. However, treatment of big quantities of the waste material can cause technical problems in practice.

Option 2.3. Grinding of the contaminated material

Grain for processing and meal for fodder production contaminated with *Ambrosia* spp. may be ground to damage siconia of the weeds if the use material of concern allows application of such a treatment. Grinding should be made in a way, allowing complete destruction of siconia. It is desirable to prepare parameters of grinding such as diameter of particles obtained by grinding of small quantity of the product at first and examining ground material for the presence of the siconia.

However, it was found that siconia of *A. artemisiifolia* were able to germinate after grinding (Wachowiak, 2000).

Ground material contaminated with *Ambrosia* spp. may be used after processing as a fodder (Shamonin and Smetnik, 1986).

Option 2.4. Other treatments

As it was mentioned previously, Wachowiak (2000) found, that treatment of contaminated products with high temperature (150°C) for 30 minutes prevented *Ambrosia* seeds from germination. This treatment could be used only in such a case when it does not affect harmfully the quality of the product. Cereal and maize grain as well as the waste material remained after cleaning can subject to the fermentation treatment, which destroys siconia of the weeds.

Option 3. Management during transportation

The spread of *Ambrosia* spp. may occur also during transportation. Seeds, grain etc. contaminated with *Ambrosia* may be poured out from untaught packages (especially sacks) and means of transport. If conditions on roadsides, near railway tracks etc. are suitable, seeds of the weeds can germinate.

So, it is necessary to transport of contaminated material or material suspected to be contaminated with the weeds in tight closed containers and means of transport. Places near roads and railway tracks where such a material is transported as well as places of re-loading of this material and places near warehouses where this material is stored should be carefully examined for the presence of *Ambrosia* plants in the period from spring to autumn.

Option 4. Management to control the final use of imported plant material within the PRA area

The material originating in the area where *Ambrosia* spp. occurs, likely to be contaminated should be transported to earlier determined places only. The material for processing should be re-loaded, stored and processed in places situated far away from crop fields. If the material is intended for sowing, the field where it was sown should be carefully checked for the presence of the weeds, even if no siconia were found during examination of samples taken from such a material.

2. Applicability to particular pathways

The risk management options should apply to all plant products, which are likely to be contaminated with *Ambrosia* spp.

Although control of the weeds in the crops should provide assurance for all pathways, it is likely to have any potential when the final product justifies the costs involved in such a control, only. However, the value of the sowing material, grain for processing and meals for fodder production is usually high, so the control is profitable.

The cleaning and grinding of contaminated material follows additional costs, delay in the dispatch of the consignment etc. It causes the rise of the price of given commodity and this can decrease the number of potential customers.

3. Conclusions of risk management

The level of phytosanitary assurance of any method for the reduction of the incidence of *Ambrosia* spp. is related to the consistency with which the method is applied over the long term. The degree of quality control of the sowing material, the grain for processing and meals for fodder production differs considerably between procedures of such a control used in different countries. So, the quality of such materials is also various.

The control of *Ambrosia* spp. in crops is the crucial method for reducing of the incidence of the weeds. However, the intensive chemical control may affect the biodiversity in agroecosystems, may cause death of profitable organisms and may cause pollution of the soil and ground waters. So, methods of integrated control of the weeds should be elaborated.

Conclusion on option 1. Control of the weeds in crop fields is an essential method of reduction the number of plants of Ambrosia *spp. It is desirable to elaborate of biological or integrated methods of such a control to avoid pollution of the soil and ground waters with the chemicals.*

Management during processing is necessary if control of the weeds in the crops is not appropriately efficient. The procedures used in such a management allow excluding and damage of siconia contaminating products, and consequently preventing them from further spread.

The inspection for siconia to confirm freedom from *Ambrosia* spp. is very important part of the pests' management. It allows finding the weeds in the consignments of plant products and subject contaminated commodities to cleaning or grinding.

Conclusion on option 2.1. Each consignment of sowing material, the grain for processing and the meal for fodder production should be carefully inspected for the presence of siconia of Ambrosia *spp. Taking into account results of such an inspection, a decision of cleaning or grinding of the commodity should be taken, if necessary.*

Cleaning of the contaminated plant material is theoretically an effective method allowing excluding of siconia from the plant material. If such a material is heavily contaminated with the weeds, some siconia may remain in it after cleaning. The choice of proper method of cleaning is very important.

Conclusion on option 2.2. Cleaning of the plant material contaminated with Ambrosia *spp. is a method, which may be used if control measures in the crops are not efficient. The choice of proper parameters of the cleaning process is very important.*

Grinding of the contaminated plant material may be done only if the treated product can be used for processing. No seeds capable for germination should be found after grinding. However, as it was mentioned previously, siconia of *A. artemisiifolia* can survive this treatment.

Conclusion on option 2.3. Grinding of the plant material contaminated with Ambrosia *spp. is a method, which may be used for decontamination of some material for processing if control measures in the crops are not efficient. The choice of proper parameters of the grinding process is very important.*

The heat treatment or submission of the product to fermentation are potential methods, which could make the seeds of *Ambrosia* spp. unable for germination. These methods need to be evaluated fully before their introduction as viable option. However, the material for processing could subject to these treatments, only.

Conclusion on option 2.4. Other treatments should be investigated further with a view to development as viable alternative phytosanitary methods.

The management during transportation of plant material, which is likely to be contaminated with *Ambrosia* spp., because untaught packages (especially sacks) and means of transport may simplify the spread of the weeds.

Conclusion on option 3. The management during transportation has a big value in preventing the weeds from spreading during the movement of consignments of contaminated of potentially contaminated plant material.

The management to control the final use of the plant material is very important because the probability of spread of the weeds into crop fields may be various, depending on destination of such a material. For instance, localisation of factories where contaminated material is cleaned or processed near crop fields is incorrect because it is conductive for infestation of such fields with the weeds.

Conclusion on option 4. The management to control the final use of the plant material has a big value. It allows predict the risk caused by the material which is lik
ely to be contaminated with the weeds during its processing, by proper localisation of processing factories, places of cleaning of the plant material etc.

4. Risk of failure

Each method of ensuring freedom of *Ambrosia* spp. may fail in practice and would lead to the full potential of the intrinsic risk being realised.

Option 1 carries high risk of failure because of difficulties in control of *Ambrosia* spp. in crop fields. In the soil of infested fields numerous siconia and/or creeping roots of these weeds may be present. Damaging of these siconia or roots is very difficult. The proper term (date) of control measures is also very important, because the weeds have to be destroyed before their fructification.

Option 2.1 has a lower risk of failure. The probability of detection of the siconia of *Ambrosia* spp. depends on the level of infestation (contamination), *Ambrosia* species, kind of product and the method of examination of the product used, the size of samples etc. For instance, if the level of infestation is very low and the size of samples taken is too little, the siconia may remain undetectable.

Options 2.2 and 2.3 have moderate risk of failure. The efficiency of cleaning depends on chosen parameters of this process and the level of infestation (contamination) of the plant product. The efficiency of grinding also depends on chosen parameters of the process and size of the siconia. In compliance with above it should be mentioned that in cleaned or ground material the siconia of *Ambrosia* spp. might occur.

Option 3.0 may fail if the products likely to be contaminated are transported in untaught packages and means of transport.

Option 4.0 may fail if the material declared as destined for processing is used for sowing. This option may also fail if places of cleaning or processing of the plant material, which is likely to be contaminated, are localised in the nearest vicinity of crop fields.

5. Risk Management for *Ambrosia* spp in Poland

In Poland all weeds from the genus *Ambrosia* subject to compulsory control on the basis of the following legal regulations: Law of February 16, 2001 on the protection of crop plants, Directive of Ministry of Agriculture and Rural Development of September 18, 2001 on the control of harmful organisms, and technical regulations which are orders of the Main Inspector of Plant Protection. These weeds have been recognized as quarantine organisms in Poland since 1990.

Above mentioned legal regulations put the owner of the ground or commodity of plant material under an obligation to inform the branch of the Plant Protection Inspection Service (PPIS) as regards the region on the suspicion of presence of harmful organism subject to compulsory control and to conduct control of this organism. They also define measures to be undertaken to control of given harmful organisms as well as detailed principles of conducting of examination and monitoring of particular pests, including *Ambrosia* spp.

- **Surveys within territory of the country**

In accordance with Polish phytosanitary regulations, harmful organisms mentioned in the Appendix 1 to the Directive of Ministry of Agriculture and Rural Developmpent of September 18, 2001 on the control of harmful organisms, including *Ambrosia* spp. subject to compulsory control.

Inspectors of PPIS conduct official inspections (surveys) to detect these organisms. Surveys for all *Ambrosia* spp. are conducted in all seed crops (plantations), commercial crops, which are likely to be infested with these weeds, re-loading places, areas situated nearly bigger warehouses as well as grain processing and fodder industry factories and on ruderal places, such as railway embankments, roadsides, slopes, rubbles and waste lands. Moreover, whole sowing material (100%) is obligatory examined in laboratories of the Inspection. The plant material stored in warehouses, grain elevators etc. – grain for consumption, fodder purposes and processing as well as cereal products also subject to examination.

Minimal number of warehouses in the area of activity of Regional Unit of PPIS, which are inspected by inspectors of PPIS is as follows (table 1).

Table 1. Minimal number of warehouses in the area of activity of Regional Unit of PPIS that should subject to inspection

Number of warehouses and grain elevators in the area of activity of Regional Unit	Number of warehouses and grain elevators to be inspected
Less than 10	All
10 – 100	20%, but not less than 10
Above 100	10%, but not less than 20

Manners of the surveillance as well as methods of sampling and examination of plant material are described in detail in technical regulations.

Numbers of surveys for the presence of *Ambrosia* spp. conducted in Poland in the period 1997-2000 by inspectors of Plant Protection Inspection are presented in table 2. Foci of the weeds occurred mainly on ruderal places, and they were found in agricultural crops, mainly cereals, occasionally only.

Table 2. Number of surveys and issued administrative decisions of *Ambrosia* control in Poland in the period 1997-2000

Year	**Surveys of crop fields**	**Surveys of orchards and vegetable crops**	**Surveys of ruderal places**	**Surveys of re-loading places**	**Number of administrative decisions on *Ambrosia* spp. control**
1997	47,930	37,483	1,551	116	34
1998	51,686	42,386	3,927	185	33
1999	58,675	43,715	3,846	374	12
2000	97,397	42,952	5,831	381	9

Moreover, for example in 2000, lots of plant material stored in 1898 warehouses and 787 grain elevators were examined, and 5690 means of transport were inspected for the presence of *Ambrosia* spp. Siconia of these weeds have never been found in Polish plant material.

- **Eradication of foci of *Ambrosia* spp. in Poland**

In Poland all foci of weeds of the genus *Ambrosia* found in crop fields and on ruderal places are officially controlled. The programme of control has been specified in the technical regulations. In the aim of disseminating among producers of plant material, this programme additionally included in the book written by Elżbieta Małuszyńska, Wiesław Podyma, Jerzy Drzewiecki and Witold Karnkowski "Weeds and parasitic weeds of quarantine importance", Fundacja "Rozwój SGGW", Warszawa, 1998 (in Polish).

Principles of control of the weeds are issued on the strength of the administrative decision of Voivodship Inspector of Plant Protection. The number of administrative decisions concerning control of *Ambrosia* spp. issued in the period 1997–2000 is presented in table 2. The owner of infested ground or lot of plant material is obliged to carry out required weed control measures in fixed date. Inspectors of PPIS check whether required measures have been carried out. Fields and areas where *Ambrosia* spp. had been found and their foci have been eradicated are surveyed to detect re-emerged weed plants.

When *Ambrosia* spp. are found on the territory of Poland, the following measures are undertaken obligatory to control and prevent the weeds from spreading.

Methods of control of the weeds

1. Small foci of ragweeds on cultivated fields and on ruderal places have to be destroyed using mechanical methods, such as removing and burning of whole plants of weeds, including the whole root system of perennial species from the genus *Ambrosia*. The weeds have to be destroyed immediately after their detection. Places of occurrence of weeds and the area within a radius 1.5 m around have to be treated with the use of herbicides. Big foci of weeds have to be controlled with herbicides. The usage of proper herbicides gained admittance to application by the Minister of Agriculture and Rural Development is approved, only.
2. In the fields infested with *Ambrosia* spp., where direct control of these weeds was conducted, proper agricultural measures have to be taken to avoid the possibility of regeneration of foci of the weeds. The kind of these measures depends on *Ambrosia* species involved.
3. Tools, clothes, boots and wheels of vehicles have to be cleaned after work on infested fields. The plant debris has to be removed from fields and destroyed by combustion.
4. Straw, hay, soil and packing material originating in infested fields must not be transported out of the infested farm.
5. Seeds deriving from crops infested with *Ambrosia* spp. must not be used for sowing.
6. Grain originating in crops infested with *Ambrosia* spp. has to be examined for the presence of the weeds siconia.
7. Grain contaminated with *Ambrosia* spp. or originating in fields infested with these weeds has to be cleaned in a seed cleaner or ground in destined place situated as close as possible from the foci. Grinding should be conducted in a manner, which enables the destroying of the siconia completely. After cleaning and grinding the material is intended for consumption, fodder purposes or further processing.
8. In crop fields found to had been infested with *Ambrosia* spp., it is necessary to comply with the proper date and method of sowing. The sowing norm has to be higher by 10–15% than the normally recommended one.

It should be pointed out that siconia of these weeds have never been found in Polish sowing material as well as grain and phytosanitary measures mentioned under points 5 – 7 are provided for such a possibility.

Preventive measures

1. The regular inspections of fields and ruderal places where *Ambrosia* spp. are likely to occur have to be conducted with the aim of detecting of occurrence of the weeds.
2. The sowing material, grain for processing, straw and hay have to be examined for the presence of siconia of *Ambrosia* spp.
3. The usage of the sowing material free from siconia *Ambrosia* spp., originating in fields free from these weeds is allowed, only.

Phytosanitary measures carried out by Plant Protection Inspection Service are efficient and allow keeping the number of these weeds at low level.

- **Inspection of imported plant material**

In accordance with Polish phytosanirary regulations, consignments of plant material imported to Poland must be free from all harmful organisms subject to compulsory control, including *Ambrosia* spp. Therefore, consignments of plant material destined for export to Poland have to be inspected and found free from all above mentioned organisms.

Inspectors of Border Points of Entry of PPIS sample and examine imported plant material for the presence of *Ambrosia* spp. The whole material for sowing, consumption, fodder and processing is subject to such examinations. Methods of inspection and sampling are described in technical regulations.

Lots contaminated with siconia of *Ambrosia* are rejected and returned to sender to avoid the introduction of the weeds into the territory of Poland. It is not possible to conduct cleaning, grinding or other treatment of contaminated plant material on the area of the border points of entry, whilst long-lasting transportation to the places, where the phytosanitary treatment of the consignment can be performed, is likely to contribute to spread of the weeds.

In the period 1996–2000 weeds from the genus *Ambrosia* were found in 639 consignments of plant material imported to Poland. In the first half-year of 2001, 23 consignments of such a material were rejected due to presence of these weeds. Contaminated plant material originating mainly in European countries, including member states of the European Union.

PART E. OVERALL CONCLUSIONS OF THE PRA

Key conclusions

The key conclusions from this PRA are as follows:

1. *Ambrosia* spp. are quarantine pests justifying the use of phytosanitary measures to exclude them from the PRA area. This conclusion is on the fact that:
   - *Ambrosia* spp. are rare in the PRA area and they occur mainly on ruderal places;
   - the entire or almost entire PRA area is suitable for establishment of *Ambrosia* spp.;
   - the crops, which may be infested with the weeds occur universally in the PRA area;
   - *Ambrosia* spp. are of potential economic importance of the PRA area.
2. *Ambrosia* spp. are known in the world to cause losses in crops of economic importance in the PRA area.
3. The presence of *Ambrosia* spp. in crops of the PRA area would be prejudicial to Polish trade.
4. The risk of *Ambrosia* spp. to the PRA area varies with different elements of each of the identified pathways;
   - origin;
   - commodity;
   - volume of trade;
   - final use.
5. The risk of introduction of *Ambrosia* spp. is higher when volumes of trade are large.
6. All consignments of sowing material and grain for processing of cereals, maize, soya bean, sunflower etc. from infested areas/sources warrant phytosanitary measures.

Management options

Several management options were considered among which three:

- intensive control of the weeds in crops;
- cleaning of contaminated plant material;
- grinding of contaminated material for processing

could give adequate phytosanitary protection.

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