AGRONOMY SCIENCE
wcześniej – formerly
Annales UMCS sectio E Agricultura
VOL. LXXIV (1) 2019

 http://dx.doi.org/10.24326/as.2019.1.6

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Alien invasive as well as rare and endangered species in the agrocenoses of the Ułęż commune

Obce gatunki inwazyjne oraz rzadkie i zagrożone w agrocenozach gminy Ułęż

Summary. The paper analyses the presence of invasive alien species and rare taxons among crop weeds in the Ułęż commune. The study is based on phytosociological relevés taken according to the Braun-Blanquet method. In total, 99 phytosociological relevés were taken. The research was conducted in 2016 and 2017. Ten rare regional and cross-regional species were found among weeds in cultivated crops. These were: *Agrostemma githago, Arnoseris minima, Avena strigosa, Chenopodium polyspermum, Consolida regalis, Veronica opaca, Veronica polita, Veronica agrestis, Bromus secalinus*, and *Centaurea cyanus*. Some of the most common species in that area included *Centaurea cyanus* and *Bromus secalinus*, while *Avena strigosa* also belonged to frequent components of the local flora. Other species were recorded rarely or very rarely. Additionally, in the crops, there was a group of 16 invasive alien species. *Setaria pumila* had the largest vegetal cover and the largest number of positions. There were some more frequently recorded species like *Echinochloa crus-galli, Galinsoga parviflora* and *Conyza canadensis*, with *Avena fatua* being quite common as well. Other species quite often found were: *Amaranthus retroflexus, Galinsoga ciliata, Veronica persica* and *Oxalis fontana*. However, species such as *Setaria viridis, Solidago canadensis, Bidens frondosa, Epilobium ciliatum, Alopecurus myosuroides, Bromus sterilis* and *Parthenocissus inserta* were rarely or very rarely found in the crops.

Key words: endangered species, invasive species, agricultural cultivations, Wieprz Glacial Valley

INTRODUCTION

Climate change and changing production technology of agricultural produce entails a change in the conditions for the occurrence and development of weeds accompanying

agricultural crops [Davies 2008, Kolářová et al. 2013]. Some species become rare and threatened with extinction, while others intensify and extend their occurrence [Lososová et al. 2004, Climová et al. 2009, Kolářová et al. 2013]. There is an increase in coverage of these species and their competitiveness with regard to cultivated species. The expansion of some weed species is an important economic problem [Tryjanowski et al. 2011, Storkey et al. 2012, Rzymowska 2013, Rzymowska et al. 2015]. In growing weeds, the occurrence of nitrophilic, monocotyledonous and neophyte species increases [Davies 2008, Rzymowska 2013]. Agrocenoses, as transformed communities, are also susceptible to the invasive spread of alien species. Many of them are typical field weeds. Invasive alien species include many species of grasses: *Anthoxanthum aristatum* [Korniak 1992, Skrzyczyńska et al. 2010, Tokarska-Guzik et al. 2012], *Avena fatua* [Korniak and Hołdyński 1996, Rzymowska and Skrzyczyńska 2004, Kapeluszny and Haliniarz 2010, Dąbkowska and Łabza 2010, Trzcińska-Tacik et al. 2010], *Echinochloa crus-galli* [Rzymowska et al. 2005, Davies et al. 2008, Dąbkowska and Łabza 2010] and many others. Weeds from the group of epecophytes [Tokarska-Guzik et al. 2012] are also potato weeds: *Galinsoga parviflora* and *Galinsoga ciliata* [Trzcińska-Tacik et al. 2010, Wnuk and Ziaja 2010].

Most researchers point to a massive decline in the species composition and the unification of communities weeding various crops [Hołdyński and Woźniak 1994, Skrzyczyńska 1999, Ziemińska-Smyk 2012]. They emphasize the retreat of speirochoric species as weeds associated with traditional, extensive methods of production [Hołdyński and Woźniak 1994, Zając et al. 2009, Storkey et al. 2012]. The reasons for the disappearance of many weed species are: increased fertilization and the use of chemical weed agents, the use of certified or well-purified own seed [Storkey et al. 2012, Rzymowska 2013]. In addition, the increase in agricultural technology and changes in the land use and crop structure contribute to this simplification in cultivation and crop rotation [Siciński 2003, Bomanowska 2010]. Rare species as well as foreign invasive species shape the biodiversity of segetal communities. Their occurrence in weed infestation in the Ułęż commune seemed particularly interesting due to the location of a significant part of the commune in the protected areas: the Protected Landscape Area "Wieprz Glacial Valley" and "Lower Wieprz" habitat refuge PLH060051 [Lokalny Program Rewitalizacji… 2017].

The aim of the study was to analyze the occurrence of alien invasive species in weed infestation and the presence of supra-regional and regional rare species in the agrocenoses of the Ułęż commune.

AREA OF RESEARCH

Ułęż is a rural commune, located in the Ryki County, in the north-western part of the Lublin province. In terms of physico-geography, the commune of Ułęż belongs to the mesoregion Wysoczyzna Żelechowska, a macro-region of the Southern-Podlasie Lowland. The Small Mazovia region, in which it is located, constitutes the borderland of Mazovia, Małopolska and Podlasie [Lokalny Program Rewitalizacji… 2017]. The commune is located within a structural unit known as the Lublin ditch. Its filling consists of Cretaceous, Tertiary and Quaternary formations. The deepest layer is formed by carbonate rocks from the upper Cretaceous. The Tertiary roof, which is represented by the

Pliocene muds, is located at a depth of 90–100 m in the Wieprz valley and 140 m – on the plateau. Quaternary is formed by formations from the period of the Kraków and Middle-Poland glaciation (mainly sandy-loamy) and the youngest, Holocene, mainly sediments, alluvia, peats and river sands. It is the building material of the Wieprz valley bottom and terraces occurring on its slopes [Lokalny Program Rewitalizacji… 2017].

In the southern part of the commune, there is the Wieprz valley, which is an important ecological corridor with a national rank connecting the Vistula and Bug valleys. The nature and landscape attractiveness of the Wieprz river valley is determined by forestry complexes, vast wet meadows and shrub communities. A significant part of the commune is located within the Protected Landscape Area of Wieprz Glacial Valley (58.2% of the area) and is included in the habitat protection under the Natura 2000 network "Lower Wieprz" PLH060051 (17%) [own development based on an interactive map http://geoserwis.gdos.gov.pl/mapy/]. It is a protected area due to the distinctive landscape with diverse ecosystems. Particular protection is given to the communities of the sub-continental lime-oak-hornbeam, riverside ash-elm and alder forests as well as meadows of varying degrees of humidity. Habitats in the river valley are a place of breeding and life of many species of protected fauna, especially amphibians (including European pond turtle, European newt, European toad, fire-bellied toad), dragonflies and butterflies, water-marsh birds, meadow and shrubs habitats birds [Lokalny Program Rewitalizacji… 2017].

The soil cover of the Ułęż commune consists of leached brown soils (found in the whole commune), pseudo-podzolic (dominating in the northern part of the commune), muds (almost exclusively limited to the Wieprz valley), and black soils developed in continuously or periodically wetland depressions. Medium-quality soils predominate. The best soils (bonitation classes I–III) occupy 22.3% of the arable land area. In general, soils in the Ułęż commune are easy to grow mechanically and are not susceptible to water erosion, except for the marginal zone of the Glacial Valley. The largest area in the general area is occupied by soils of complex 4 (very good rye) constituting 24.8% of the agricultural land area, the concentration of which is in the northern part of the commune [Studium uwarunkowań… 2012].

In the land use structure of the Ułęż commune, arable land accounts for 66.5% of the total land area, including arable land 43.7% [GUS 2014]. The share of forest complexes and wooded areas (27.6%) is relatively high, with a forest cover of 21.4%. The share of developed and urbanized land is 3.3% of the commune's area. Among them, the largest area is road communication areas (87.5%), while residential areas are only 1.4% [Studium uwarunkowań… 2012]. Surface waters also have a significant share occupying 6.7% of the area. In addition to the river, there are oxbow lakes, peat bogs, ponds and complexes of breeding ponds in the following villages: Ułęż, Sobieszyn, Żabianka, Podlodów and Sarny.

The agrarian structure of the Ułęż commune is unfavorable, as farms with a small area dominate. The average area of an agricultural farm in a commune is 5.31 ha. In the area of the commune, there are only 4 farms with an area of over 50 ha. Determinants for the development of agriculture in the studied area can be described as moderately good. The crop structure is dominated by cereals (rye, triticale, wheat and oats), constituting 86% of the sown area. Other crops are mainly silage maize, root crops and fruit. In addition to orchards, strawberries and currants are grown in the commune. Overall, they constitute 14% of the cultivated area [Studium uwarunkowań… 2012].

METHODS

Observations of weed infestation in the Ułęż commune were conducted in 2016–2017. The research covered all 13 localities in the commune. They consisted in the implementation of phytosociological relevés using the Braun-Blanquet method on an area of 50 m^2 [Pawłowski 1977] in crops of winter and spring cereals and potatoes. Observations were made at the optimal time for the development of the studied communities. In cereals, relevés were taken at the end of June and in July, while in the root crops – at the end of August. Positions, at which the research was conducted, were selected on the basis of soil and agricultural maps in the scale of 1:5000, therefore they would reflect the soil conditions in the studied area. In total, 99 phytosociological relevés were taken. In winter cereals, 41 phytosociological relevés were taken (11 on light and 30 on compact soils), 33 in spring cereals (analogously: 10 and 23) and 25 on potato plantations (10 and 15).

To determine the share of alien invasive as well as rare and endangered species in weed infestation, the relevés are listed in tables depending on the compactness of the soil and crop group. For this purpose, the relevés were divided into groups, conveying 2 categories of soil compactness conventionally: light and compact. Clay soils and sandy loam soils were classified as compact soils. They were soils classified as complexes: very good rye, good wheat and cereal-fodder strong. The light soil category included sandy soils classified as complexes: weak rye, good rye and cereal-fodder rye weak. For each species in the table, phytosociological stability (S) and coverage factor (W) were calculated [Pawłowski 1977].

The nomenclature of species is based on the work by Mirek et al. [2002]. Weeding flora was analyzed for the presence of rare and endangered species. The species analyzed were selected on the basis of the "Red list of vascular plants of the South Podlasie Lowland" [Głowacki et al. 2003] and "Lists of endangered segetal species in Poland" [Warcholińska 1994]. On the basis of the above-mentioned works, hazard categories for the analyzed species were adopted: Ex – extinct and supposedly extinct species, E – extinct, EN – endangered species, V, VU – exposed to extinction, R – rare, I, DD – undetermined hazard status.

Segetal communities were also analyzed for the presence of invasive alien species. The category of invasiveness of selected species was determined based on the work of Tokarska-Guzik et al. [2012]: I – segetal or ruderal weeds, occurring with large amounts, mainly in anthropogenic habitats or potentially invasive species, currently occupying small area, II – species that already exhibit invasive properties in some regions, increase the number of positions and occupied area or they are characterized by high invasive potential in other countries, III – species occurring on a few positions in a large cover or scattered in many positions with a significant ecological, social or economic threat, IV – species the occurrence of which in our country is very important – both a large number of positions and a large number of individuals in the patches is known, with a tendency to increase the number of positions or the area occupied.

The frequency of the analyzed species occurrence was determined in relation to the number of patches, in which they were found, where: 1–2 plant patches – very rare species, 3–4 – rare, 5–8 – quite rare, 9–16 – frequent, 17–32 – quite common, 33–64 – common, over 65 – very common.

RESULTS

Segetal flora of the studied area consists of 137 species (including one species of bryophytes). In the analyzed flora, the predominance of short-lived species (90 species) over perennial (46 species) was found. In spring cereals, 112 species were found with an average number – 17 species in the relevé. Lower species abundance was found in winter cereals (78 species) and in root crops (69 species). The average number of species in the relevéwas also lower (10 and 13, respectively) (Table 1).

Table 1. The effect of crop plants on weed species diversity

Group of crops	Mean number of species in relevé	Number of species
Winter cereals	10	K – 55 W – 23 R – 78
Spring cereals	17	K – 70 W – 41 M – 1 R – 112
Root crops	13	K – 55 W – 14 R – 69
Total number of species in all crops		K – 90 W – 46 M – 1 137

Explanations: K – short-lived species, W – perennial species, M – bryophyte, R – total

In the analyzed crops, 10 rare and endangered species were found. They were: *Agrostemma githago*, *Arnoseris minima*, *Avena strigosa*, *Chenopodium polyspermum*, *Consolida regalis*, *Veronica opaca*, *Veronica polita*, *Veronica agrestis*, *Bromus secalinus* and *Centaurea cyanus* (Table 2). Significantly more positions of rare and endangered species were recorded on compact soils (59 positions) than on light soils (32 sites). The exceptions were species such as *Agrostemma githago* and *Arnoseris minima*, the individual positions of which were found only on light soils as well as *Avena strigosa* recorded more frequently in such habitats. The remaining species were recorded only on compact soils or they were much more frequent in such habitats. Of the analyzed species in the studied area, only *Centaurea cyanus* belonged to the common components of the segetal flora. It was found in 48 relevés. In winter cereals, it belonged to the dominant species of weed infestation. Sometimes, cover of this species was at the level of 20–40%. A common species was also *Bromus secalinus*, which was recorded in 15 phytosociological relevés, most often in winter cereals. Coverage of this species was rather small, but sometimes it reached 10%. The frequent weeds, especially on light soils, also included *Avena strigosa* occurring in spring crops. Coverage of this species at the position in Osmolice reached 20% (Table 2).

Table 2. Endangered species of segetal flora in the Ułęż commune

Species	Category of 'endangered'		Number of positions	Group of crops	Soil	Locality	Abundance	S	W
	1	2							
Agrostemma githago L.	EN	V	1	rye	light	Wymysłów	+	I	9
Arnoseris minima (L.) Schweigg.& Körte	LR		1	rye	light	Wymysłów	r	I	0
Avena strigosa Schreb.	E		6	oat, spring cereal mixture	light	Sobieszyn, Osmolice, Ułęż, Sarny, Podlodówka, Lendo Ruskie	1, 2, +	III	265
			4		compact		+	I	17
Bromus secalinus L.	VU	V	5	rye, winter triticale, winter wheat, spring wheat, spring mixture	light	Białki Górne, B. Dolne, Lendo Ruskie, Ułęż, Wymysłów, Sarny, Drążgów, Osmolice, Korzeniów	1, +	III	82
			8		compact		1, +	II	53
			2		compact		+	I	9
Centaurea cyanus L.		I	9	rye, winter triticale, winter barley, winter wheat, spring wheat, oat, spring cereal mixture, potatoes	light	Wymysłów, Sobieszyn, Białki Górne, B. Dolne, Lendo Ruskie, Korzeniów, Ułęż, Sarny, Drążgów, Żabianka, Osmolice,	1, 2, +	V	341
			22		compact		1, 2, 3, +	IV	277
			8		light		+	IV	80
			8		compact		+	II	35
			1		light		+	I	10
Chenopodium polyspermum L.	DD	I	2	potatoes	compact	Sarny	1, 2	I	150
Consolida regalis Gray		I	1	rye, winter triticale, spring cereal mixture	light	Białki Górne, Sobieszyn, Żabianka, Ułęż, Podlodówka	+	I	9
			3		compact		+	I	10
			1		compact		r, +	I	0
Veronica agrestis L.	LR		3	oat, spring wheat, potatoes	compact	Sobieszyn, Sarny, Białki Dolne	+	I	13
			2		compact		+	I	13
Veronica opaca Fr.	VU	V	1	spring wheat	compact	Sobieszyn	+	I	4
Veronica polita Fr.	VU	I	1	oat, potatoes	compact	Sobieszyn, Sarny, Osmolice	+	I	4
			2		compact		+	I	13

Explanations: categories of 'endangered' by: 1 – Głowacki et al. [2003], 2 – Warcholińska [1994]; S – phytosociological stability, W – phytosociological fidelity

Very rare species endangered with extinction on the studied area were *Agrostemma githago*, *Arnoseris minima*, *Veronica opaca* (Table 2). *Veronica polita* and *Veronica agrestis* were more often found. Grey field-speedwell was found on 3 positions (2 in potatoes and one position in oats). Green field-speedwell was recorded on 5 positions (3 in spring cereals and 2 in potatoes). *Chenopodium polyspermum* was found in potato cultivation in two fields, however, the coverage of this species was significant – from 5 to 20%. *Consolida regalis* belonged to quite rare species in the studied area (Table 2).

In the crops of the Ułęż commune, there were found 16 species classified as invasive alien species. Definitely more positions of alien invasive species in all crop groups were found on compact soils. Particularly large difference was found in spring cereals. Among the analyzed species, there are typical field weeds from the group of archaeophytes, such as: *Setaria pumila*, *Setaria viridis*, *Echinochloa crus-galli*, *Avena fatua* and locally found *Bromus sterilis* and *Alopecurus myosuroides* (Table 3).

Table 3. Invasive species in crop plants in the Ułęż commune

Species	Origin	Categories of invasiveness	Winter cereals		Spring cereals		Root crops	
Number of positions – number phytosociological relevés with invasive species			a	b	a	b	a	b
Alopecurus myosuroides Huds.	Ar	II	–	–	1	1	–	–
Amaranthus retoflexus L.	Ep	I	–	–	–	–	3	8
Avena fatua L.	Ar	I	–	4	2	16	–	1
Bidens frondosa L.	Ep	III	–	–	–	2	–	–
Bromus sterilis L.	Ar	I	–	–	–	1	–	–
Conyza canadensis (L.) Cronguist	Ep	I	8	14	5	6	2	–
Echinochloa crus-galli (L.) P. Beauv.	Ar	I	1	3	4	13	6	12
Epilobium ciliatum Raf.	Ep	II	–	1	–	–	–	–
Galinsoga ciliata (Raf.) S.F. Blake	Ep	I	–	1	1	3	–	7
Galinsoga parviflora Cav.	Ep	I	–	5	4	7	8	14
Oxalis fontana Bunge	Ep	I	1	2	2	10	–	–
Parthenocissus inserta (A. Kern.) Fritsch	Kn	III	–	–	–	1	–	–
Setaria pumila (Poir.) Poem et. Schhult.	Ar	I	7	12	8	15	9	9
Setaria viridis (L.) P. Beauv.	Ar	I	–	–	1	2	2	–
Solidago canadensis L.	Ep	IV	–	–	1	–	–	–
Veronica persica Poir.	Ep	IV	–	2	–	7	–	3
Total			17	44	29	84	30	54

Explanation: a – light soil, b – compact soil

The largest number of positions were found for: *Setaria pumila* (in total 60 vegetable patches, the largest in spring cereals on compact soils), *Echinochloa crus-galli* (total 39 vegetable patches, most on compact soils in spring cereals and potato crops) and *Avena fatua* (23 vegetable patches in total, most in spring cereals on compact soils). Typical segetal weeds also included species belonging to newer arrivals (epecophytes): *Galinsoga parviflora*, *Galinsoga ciliata*, *Amaranthus retroflexus*, most often found in root crops, and *Veronica persica* found in various crops on compact soils (Table 3).

Common species of *Conyza canadensis* and *Oxalis fontana*, often occurring on arable fields, were also found in ruderal and semi-natural communities (mid-field trees, fallow lands, old orchards and backyard parks). The highly invasive species included: *Solidago canadensis* (IV invasive grade) and *Bidens frondosa* (III invasive category). These were rare species found in agrocenoses in the Ułęż commune. *Epilobium ciliatum* and *Parthenocissus inserta* were also very rare species (Table 3). These are species that penetrate from wetland habitats, wastelands, meadows and rushes, and riverside bushes to arable fields due to their increased occurrence in these neighboring communities.

DISCUSSION

In the Ułęż commune, compact soils in good agricultural culture prevail. In most crops, quite intense methods are carried out. The studied agrocenoses in terms of floristic are not distinguished by large biodiversity. This was reflected in the overall number of species in the studied area and small number of species in the relevé. In total, the segetal flora consists of 137 species. This is much less compared to the flora found in communes located in protected areas: Maciejowice commune, Mazovian province (216 species) [Ługowska and Pawlonka 2016] or Borek Wielkopolski, Greater Poland province (159 species) [Celka et al. 2006]. In the analyzed flora, the predominance of short-lived (90 species) over perennial species (46 species) can be found. Similar relationships were observed in the segetal flora of other regions [Skrzyczyńska and Skrajna 1999, Ziaja 2004]. The highest species abundance (112 species) was found in spring cereals; also in this group of crops, the highest average number of species in the relevéwas found (17 species). This is probably related to the reduced intensity of weed infestation in these crops due to the use of crops for feed in own farm. In addition, soil and meteorological conditions could also have an impact on this situation [Lososová et al. 2004]. Years, when the research was conducted, were characterized by low KBW in the spring period; especially in 2016, there was a risk of drought in 2 reporting periods (1.05–30.06 and 11.05–10.07), while in 2017, in the first of the given periods. In addition, 10 days earlier and 20 days after this period, significant deficiencies in moisture were also reported [SMSR]. It should be assumed that such weather conditions negatively influenced the development of arable crops and could have an impact on the occurrence of weeds, more tolerant to changes in habitat conditions. Lack of rainfall and high temperature may have contributed to the growth of weed infestation with late emerging thermophilic species, such as *Paniceae*, *Galinsoga* species and *Amaranthus retroflexus* [Ługowska et al. 2016].

There were only 10 rare and endangered species on the studied area. These were mainly archaeophytes, which belong to the most endangered elements of flora [Tryjanowski et al. 2011]. This is not enough for an area largely covered by nature protection

compared to the above-mentioned Maciejowice commune, where 21 species were found in this group [Ługowska and Pawlonka 2016]. Among them, *Centaurea cyanus* was classified as common, and *Bromus secalinus* was classified as frequent flora components. They appeared in many positions, sometimes also in considerable coverage. *Avena strigosa* was also frequently recorded. These are weeds spread mainly with seed material, especially *Avena strigosa* belongs to obligatory speirochores. These species are often found in the conditions of extensive agriculture, among others in the Podlasie Bug Gorge due to the use of poorly purified seed grain [Rzymowska 2013]. However, a rare species from this group is *Agrostemma githago*, once a common winter cereal weed [Zając and Zając 2001]. It is a typical obligatory speirochore that under conditions of intensive management, and in particular, the use of certified seed yields disappears in segetal communities. Such reasons for the disappearance of the species' positions were indicated, among others, by Kornaś [1987], Rzymowska and Skrzyczyńska [2007], and Rzymowska [2013]. It is interesting to note that speirochoric species, such as *Avena strigosa* and *Bromus secalinus*, occur quite frequently in the studied area compared to *Agrostemma githago*. Perhaps, this indicates the differences in the possibility of cleaning seeds from *Agrostemma githago* and *Avena strigosa* seeds. *Bromus secalinus* is an optional speirochore, thus it also partially uses other seed dispersal methods. *Avena strigosa* is spread with seed material, but in the case of late harvests, partial falling during the harvest is not excluded. Perhaps, the chemical weed control is also important in this case. It should be noted that graminicides are used less frequently than herbicides fighting the dicotyledonous species, especially in the spring cereal mixture, which is most often used for fodder on the farm. As a consequence, it may have an impact on varied occurrence of these species.

Arnoseris minima was very rare and in a small number of individuals. It is an acidophilic species, especially endangered in the studied area, not only because of the isolated, small population, but also because of the lack of suitable habitats and quite intense production methods. Very rare species in the Ułęż commune were also *Veronica opaca*, *Veronica polita* and *Chenopodium polyspermum*, somewhat more often found *Veronica agrestis* and *Consolida regalis*. These are species with high requirements in relation to the abundance and fertility of habitats as well as soil pH. In general, these are rare species, however, in some regions they are recorded slightly more often, especially in the conditions of using extensive or ecological production methods [Rzymowska 2013].

A disturbing fact is the occurrence of as many as 16 species classified as invasive species in analyzed crops [Tokarska-Guzik et al. 2012], the expansion of which may have negative impact on species diversity of segetal communities [Ługowska and Pawlonka 2016]. A much larger number of their positions were recorded on compact soils, irrespective of the crop type. Invasive species are generally characterized by a wide ecological amplitude in relation to habitat conditions [Tokarska-Guzik 2005]; however, on the basis of the results of these studies, it can be concluded that they make good use of favorable habitat conditions for development and spread. Among the invasive species, the most common were: *Setaria pumila*, *Echinochloa crus-galli* and *Galinsoga parviflora*. In addition to the typical segetal weeds in the studied agrocenoses, there were also species migrating from neighboring communities such as: *Solidago canadensis*, *Bidens frondosa*, *Epilobium ciliatum* and *Parthenocissus inserta*. The first three show greater invasive potential and adaptability to field crop conditions, and may in the future become potential weeds.

CONCLUSIONS

1. Segetal communities of the Ułęż commune are characterized by low species abundance. The methods of production used are not conducive to the preservation of rare and endangered segetal species.

2. Among the rare and endangered species, speirochoric species such as *Centaurea cyanus*, *Bromus secalinus* and *Avena strigosa* were found most frequently and in the largest cover, indicating the use of their own insufficiently purified seed material.

3. The threat to biodiversity is caused by the presence of a large group of invasive alien species. Among them, species classified as class I of invasiveness have a greater share in the weed infestation of the Ułęż commune. Species with greater invasiveness were rare and very rare.

REFERENCES

Bomanowska A., 2010. Threat to arable weeds in Poland in the light of national and regional red lists. Plant Breed. Seed Sci. 61, 55–74, http://dx.doi.org/10.2478/v10129-010-0013-7.

Celka Z., Latowski K., Szymczak A., Wawrzyniak K., 2006. Zmiany we florze segetalnej gm. Borek Wlkp. (Obszar Chronionego Krajobrazu Pojezierze Krzywińsko-Osieckie). Pam. Puł. 143, 37–44.

Cimalová Š., Lososová Z., 2009. Arable weed vegetation of the northeastern part of the Czech Republic: Effects of environmen-tal factors on species composition. Plant Ecol. 203, 45–57, http://dx.doi.org/10.1007/s11258-008-9503-1.

Davies D.H.K., 2008. Changing weed species and management – then, now and tomorrow. Proceedings of HGCA Conf. „Arable cropping in a changing climate", Grantham, 23–24 January 2008, 93–102.

Dąbkowska T., Łabza T., 2010. Gatunki z rodziny *Poaceae* w uprawach zbóż na wybranych siedliskach Polski Południowej w ostatnich 25 latach. Fragm. Agron. 27(2), 47–59.

Głowacki Z., Falkowski M., Krechowski J., Marciniuk J., Marciniuk P., Nowicka-Falkowska K., Wierzba M., 2003. Czerwona lista roślin naczyniowych Niziny Południowopodlaskiej. Chroń. Przyr. Ojcz. 59, 5–41.

GUS, 2014. Bank Danych Lokalnych. Warszawa.

Hołdyński Cz., Woźniak M., 1994. Speirochoria na tle aktualnego zachwaszczenia pszenicy ozimej na Żuławach Wislanych. Mat. XVII Kraj. Konf. Nauk. „Przyczyny i źródła zachwaszczenia" Olsztyn-Bęsia, 28–29.06.1994, ART Olsztyn, 13–20.

http://geoserwis.gdos.gov.pl/mapy/

Kapeluszny J., Haliniarz M., 2010. Ekspansywne i zagrożone gatunki flory segetalnej w środkowo-wschodniej Polsce. Ann. UMCS sec. E Agricultura 65(1), 26–33.

Kolářová M., Tyšer L., Soukup J., 2013. Diversity of current weed vegetation on arable landin selected areas of the Czech Republic. Plant Soil Environ. 59(5), 208–213.

Kornaś J., 1987. Chwasty polne rozprzestrzeniane z materiałem siewnym. Specjalizacja ekologiczna i procesy wymierania. Zesz. Nauk. AR w Krakowie 216, Sesja Nauk. 19, 23–36.

Korniak T., 1992. Ekspansywne gatunki chwastów segetalnych w północno-wschodniej części Polski. Zesz. Nauk. AR w Krakowie 261(33), 27–36.

Korniak T., Hołdyński C., 1996. Ekspansja chwastów należących do traw (*Poaceae*) w północnowschodniej Polsce. In: Ekspansywne chwasty segetalne. Zesz. Nauk. ATR Bydgoszcz 196(38), 95–102.

Lokalny Program Rewitalizacji Gminy Ułęż na lata 2016–2023, 2017. Ułęż.

Lososová Z., Chytrý M., Cimalová Š., Kropáč Z., Otýpková Z., Pyšek P. & Tichý L. 2004. Weed vegetation of arable land in Central Europe: Gradients of diversity and species composition. J. Veg. Sci. 15, 415–422.

Ługowska M., Pawlonka Z., 2016. Udział gatunków zagrożonych i inwazyjnych w zbiorowiskach pól uprawnych na przykładzie gminy Maciejowice. Ann. UMCS, sec. E Agricultura 71(1), 39–52.

Ługowska M., Pawlonka Z., Skrzyczyńska J., 2016. The effects of soil conditions and crop types on diversity of weed communities. Acta Agrobot. 69(4),1–9, http://dx.doi.org/10.5586/aa.1687.

Mirek Z., Piękoś-Mirkowa H., Zając A., Zając M., 2002. Flowering plants and pteridophytes of Poland – a checklist. In: Z. Mirek (red.), Biodiversity of Poland, 1. W. Szafer Institute of Botany, Polish Academy of Sciences, Kraków.

Pawłowski B., 1977. Skład i budowa zbiorowisk roślinnych oraz metody ich badania. In: Szata roślinna Polski, 1. PWN, Warszawa, 237–268.

Rzymowska Z., 2013. Współczesne zmiany we florze i zbiorowiskach segetalnych Podlaskiego Przełomu Bugu. Rozpr. Nauk. 124, Wyd. UPH w Siedlcach.

Rzymowska Z., Skrajna T., Dunajko D., Kościuk K., 2015. Zachwaszczenie upraw zbóż na Równinie Łukowskiej. Zesz. Nauk. UPH w Siedlcach, ser. Rolnictwo 1(1), 45–65.

Rzymowska Z., Skrzyczyńska J., 2004. Występowanie *Avena fatua* L. w agrocenozach Podlaskiego Przełomu Bugu. Acta Sci. Pol. Biologia 3(2), 37–49.

Rzymowska Z., Skrzyczyńska J., 2007. Niektóre cechy biologiczne *Agrostemma githago* L. i *Centaurea cyanus* L. na różnych siedliskach Wysoczyzny Siedleckiej. Ann. UMCS, sec. E Agricultura 62(2), 82–89.

Rzymowska Z., Skrzyczyńska J., Skrajna T., 2005. Chwasty prosowate (*Paniceae*) w uprawach okopowych i zbóż jarych gm. Mrozy. Zesz. Nauk. AP w Siedlcach, ser. Rolnictwo 66/68, 53–63.

Siciński J.T., 2003. Agrofitocenozy dorzecza środkowej Warty i Bzury – stan, dynamika i zagrożenia. Rozp. Nauk., Wyd. UŁ, Łódź.

Skrzyczyńska J., 1999. Zachwaszczenie upraw Wysoczyzny Siedleckiej na tle warunków glebowych. Cz. I. Zachwaszczenie zbóż i okopowych. Rocz. Nauk. Rol. s. A 114, 137–151.

Skrzyczyńska J., Skrajna T., 1999. Flora segetalna Wysoczyzny Kałuszyńskiej. Acta Agrobot. 52(1–2), 183–202.

Skrzyczyńska J., Skrajna T., Rzymowska Z., 2010. Ekspansja *Anthoxanthum aristatum* Boiss. w uprawach rolniczych na Nizinie Południowopodlaskiej. Fragm. Agron. 27(2), 135–144.

SMSR – System Monitoringu Suszy Rolniczej. IUNG, Puławy (http://susza.iung.pulawy.pl/arch16/).

Storkey J., Meyer S., Still K. S., Leuschner C., 2012. The impact of agricultural intensification and land-use change on the European arable flora. Proc. R. Soc. B, 279, 1421–1429, http://dx.doi.org/10.1098/rspb.2011.1686.

Studium uwarunkowań i kierunków zagospodarowania przestrzennego gminy Ułęż, 2012.

Tokarska-Guzik B., 2005. The Establishment and Spread of Alien Plant Species (Kenophytes) in the Flora of Poland. Wyd. UŚ, Katowice.

Tokarska-Guzik B., Dajdok Z., Zając M., Zając A., Urbisz A., Danielewicz W., Hołdyński Cz., 2012. Rośliny obcego pochodzenia w Polsce ze szczególnym uwzględnieniem gatunków inwazyjnych. Generalna Dyrekcja Ochrony Środowiska, Warszawa.

Tryjanowski P., Dajdok Z., Kujawa K., Kałuski T., Mrówczyński M., 2011. Zagrożenie różnorodności biologicznej w krajobrazie rolniczym: czy badania w Europie Zachodniej pozwalają na poprawną diagnozę w Polsce? Pol. J. Agron. 7, 113–119.

Trzcińska-Tacik H., Puła J., Stokłosa A., Malara J., 2010. Ekspansja *Avena fatua* i gatunków z rodzaju *Galinsoga* w zbiorowiskach chwastów polnych w dolinie Wisły powyżej Krakowa. Fragm. Agron. 27(2), 164–170.

Warcholińska A. U., 1994. List of threatened segetal plant species in Poland. In: S. Mochnacky, A. Terpo (ed.), Antropization and environment of rural settlements. Flora and vegetation. Proceedings of International Conference. Satoraljaujhely, 22–26 August, 206–219.

Wnuk Z., Ziaja M., 2010. *Galinsoga* sp. w zbiorowiskach segetalnych Pasma Przedborsko-Małogoskiego. Fragm. Agron. 27(3), 159–166.
Zając A., Zając M., 2001. Atlas rozmieszczenia roślin naczyniowych w Polsce. UJ, Kraków.
Zając M., Zając A., 2014. Survival problems of archaeophytes in the Polish flora. Biodiv. Res. Conserv. 35, 47–56, http://dx.doi.org/10.2478/biorc-2014-0015.
Ziaja M., 2004. Flora segetalna Doliny Strugu w województwie podkarpackim. Acta Sci. Pol. Biologia, 3(2), 77–100.
Ziemińska-Smyk M., 2012. Zmiany w zachwaszczeniu upraw zbóż na Zamojszczyźnie gatunkami z rodziny traw (*Poaceae*). Zesz. Nauk. UP we Wrocławiu, Rolnictwo C, 584, 159–163.

The research carried out under the project No. 445/15/S was financed from a grant for science, awarded by the Ministry of Science and Higher Education.

Streszczenie. W pracy przedstawiono analizę występowania obcych gatunków inwazyjnych oraz taksonów rzadkich w zachwaszczeniu upraw gminy Ułęż. Badania polegały na wykonaniu zdjęć fitosocjologicznych metodą Braun-Blanqueta, łącznie wykonano 99 zdjęć. Badania przeprowadzono w latach 2016–2017. W zachwaszczeniu upraw stwierdzono występowanie 10 gatunków rzadkich regionalnie i ponadregionalnie. Były to: *Agrostemma githago, Arnoseris minima, Avena strigosa, Chenopodium polyspermum, Consolida regalis, Veronica opaca, Veronica polita, Veronica agrestis, Bromus secalinus* i *Centaurea cyanus*. Wśród nich *Centaurea cyanus* był pospolitym gatunkiem, a *Bromus secalinus* i *Avena strigosa* należały do częstych składników flory. Pozostałe gatunki notowano rzadko lub bardzo rzadko. W badanych uprawach zanotowano grupę 16 obcych gatunków inwazyjnych. Największą liczbę stanowisk i pokrycie stwierdzono dla *Setaria pumila.* Pospolitymi gatunkami inwazyjnymi były również *Echinochloa crus-galli, Galinsoga parviflora* i *Conyza canadensis*, a dość pospolitym *Avena fatua*. Często notowano też *Amaranthus retroflexus, Galinsoga ciliata, Veronica persica* i *Oxalis fontana*. Natomiast gatunki, takie jak: *Setaria viridis, Solidago canadensis, Bidens frondosa, Epilobium ciliatum, Alopecurus myosuroides, Bromus sterilis* i *Parthenocissus inserta* rzadko lub bardzo rzadko spotykano w badanych uprawach.

Słowa kluczowe: gatunki zagrożone, gatunki inwazyjne, uprawy rolnicze, Pradolina Wieprza

Received: 4.02.2019
Accepted:14.04.2019