УДК 581. 5:632

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SYNTAXONOMIC EVALUATION OF WEED COMMUNITIES IN CEREAL AGROCENOSES

Phytosociological and syntaxonomic evaluation of weed communities was conducted in cereal monoculture and crop rotation. In communities of weeds occurring in spring and winter cereals sown in a monoculture and crop rotation, there were identified species representing six syntaxonomic classes: STELLARIETEA MEDIAE R.Tx, Lohm. et Prsg 1950, ARTEMISIETEA VULGARIS Lohm. Prsg et R.Tx. 1950, MOLINIO-ARRHENATHERETEA R. Tx. 1937 (1970), AGROPYRETEA INTERMEDIO-REPENTIS (Oberd. et all. 1967) Müller et Görs 1969, KOELERIO GLAUCAE-CORYNEPHORETEA CANESCENTIS Klika in Klika et Nowak 1941 and BIDENTETEA TRIPARTITI R. Tx., Lohm. et Prsg 1950. Results achieved in the study demonstrated that both in the monoculture and in crop rotation, the formation of segetal weeds associations followed the scheme being typical of cereal crops. Despite that, weed communities were formed in both systems of cereal cultivation with a high contribution of species typical of the root crops.

Key words: *Syntaxonomy, species diversity, crop rotation, monoculture, weeds*

Introduction. Species composition, the number and biomass of weeds in cultivated plants are a resultant of the effects of interactions proceeding between habitat conditions, agrotechnical treatments and characteristics of a cultivated plant [8, 24]. A significant role in weed communities development is also ascribed to the succession of plants in crop rotation [18, 22]. Contemporary farming is mainly based on extremely reduced crop rotations and cereal monocultures, which leads to increased weed infestation of cultivated plants [18]. A research by Soroka [16] demonstrates that plants succession, properties of soil cover and hydrothermal parameters of the habitat contribute to the formation of communities of segetal weeds typical of arable fields.

Weed infestation of cereals depends also on the method of weed control [10, 15], and on tillage system [13, 20, 25].

In turn, the effectiveness of weed control is influenced by plants succession in crop rotation and by the method of weed management [22].

According to Chikowo et al. [4], the most effective are integrated methods of weed control, but Brandsæter et al. [1] points to high herbicidal effectiveness of cereals harrowing in two terms. Also Pardo et al. [12] reports that at low-input farms the harrowing of cereals is an important treatment reducing weed infestation, and that at commercial farms the highest herbicidal effectiveness is achieved upon the use of herbicides. In investigations conducted by Woźniak [22] herbicides applied in a maize monoculture caused compensation of selected species of weeds. Also Chauhan et al. [3] show that continuous repeated cultivation of the same plants leads to the occurrence of predominating weeds.

The aim of this study was phytosociological and syntaxonomic evaluation of weed communities occurring in winter and spring cereals sown in a monoculture and in crop rotation.

Material and methods. A strict field experiment was conducted in the years 1988–2012 at the Experimental Station Uhrusk (51°18'12"N, 23°36'50"E) (University of Life Sciences in Lublin, Poland), aimed at cereals cultivation in a monoculture and 4-field crop rotation (Table 1). The 24-year period of the study was divided into 6 cycles, 4 years each. The following cereals were sown in the particular cycles: winter triticale (*Triticosecale* Witmack) in the first and second cycle, spring triticale in the third cycle, winter wheat (*Triticum aestivum* L.) in the fourth cycle, and spring wheat in the fifth and the sixth cycle. The experiment was established in 4 replications in blocks with sizes of 7.5 m x 25 m (Fig. 1 and 2). The soil the experiment was established on was Rendzic Phaeozem (IUSS Working Group WRB) [9] with the composition of poorly sandy light clay. The content of available forms of phosphorus in soil is 137 mg P kg^{-1}, that of potassium is 203 mg K kg^{-1} and pH value of soil is slightly alkaline (pH_{KCl}=7.2). The content of total N in the soil is 1.03 g kg^{-1}, whereas that of organic C is 7.60 g kg^{-1}. According to the Agrometeorological Station in Uhrusk, at the

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study area, the annual total precipitation accounts for 578 mm, whereas the mean air temperature – for 7.5ºC (data of the years 1965 to 2010). In the period since sowing till harvest (since April till August), the sum of precipitation reaches 320 mm whereas air temperature reaches 14.8ºC on average.

Fig. 1. A general view of the experience (Photo by A. Woźniak)

Fig. 2. Potatoes in crop rotation (Photo by A. Woźniak)

Conventional tillage and standard doses of fertilizers were applied in both systems of plants succession. Organic fertilizers in the form of bovine manure in a dose of 25 t ha^{-1} were applied on all fields of crop rotation and monoculture once in the rotation (every 4 years). Sowing density reached 400 grains m^{-2} for winter triticale, 450 grains m^{-2} for winter wheat and 550 grains m^{-2} for spring triticale and spring wheat. The winter cereals were sown in the third decade of September, and spring cereals in the first decade of April. Weed control of cereals was conducted mechanically by twofold harrowing. In winter and spring cereals this treatment was conducted at the tillering stage (22/23 in Zadoks scale) [27] and 10-14 days later.

Table 1

Scheme of crop rotation in the experiment

Cycles of cropping systems	Mono-culture	Crop rotation
1 (since year 1 till year 4 of the study)	WTr	P – WTr – Pe – WTr*
2 (since year 5 till year 8 of the study)	WTr	P – WTr – Pe – WTr*
3 (since year 9 till year 12 of the study)	STr	P – STr – Pe – STr*
4 (since year 13 till year 16 of the study)	WW	P – WW – Pe – WW*
5 (since year 17 till year 20 of the study)	SW	Pe – SB – Pe – SW*
6 (since year 21 till year 24 of the study)	SW	Pe – SW – Pe – SW*

WTr = Winter triticale (Bolero and Presto cv.), STr = Spring triticale (Migo cv.), WW = Winter wheat (Korweta cv.), SW = Spring wheat (Opatka and Koksa cv.), P = Potato, Pe = Peas, SB = Spring Barley, *studied plots in the crop rotation

The phytosociological and syntaxonomic evaluation of weed communities in the cereal monoculture and crop rotation was carried out according to the method of Braun-Blanquet [2]. In total, within 24 years of the study, 1920 phytosociological releves were taken. The quantity of weeds was determined in a scale of 5 to 1 and with symbols: + and r, where: 5 – free number of specimens, ground coverage >75%; 4 – free number of specimens, coverage 50-75%; 3 – free number of specimens, coverage 25-50%; 2 – high number of specimens, coverage 5-25%; 1 – higher number of specimens (from 5 to 50), coverage ca. 5%; + – low number of specimens (from 2 to 5), coverage <5%; and r – one specimen. The following scale was applied to evaluate constancy degree of weeds occurrence: V (80-100%), IV (60-80%), III (40-60%), II (20-40%), and I (<20%). Results were collated in tables, according to the scheme adopted by Soroka (2008). Names of plant species were provided according to Flora Europea [6], whereas synonym names according to Tasenkevich [19]. Names and structure of syntaxons, and syntaxonomic scheme were adopted after Matuszkiewicz [11]. Names of moss species were reported according to Corley et al. [5], whereas names of the hepatics according to Grolle [7].

Results. In the community of weeds occurring in winter and spring cereals sown in the multi-year monoculture and crop rotation there were isolated species that belonged to six syntaxonomic classes: *STELLARIETEA MEDIAE* R.Tx, Lohm. et Prsg 1950, *ARTEMISIETEA VULGARIS* Lohm. Prsg et R.Tx. 1950, *MOLINIO-ARRHENATHERETEA* R. Tx. 1937 (1970), *AGROPYRETEA INTERMEDIO-REPENTIS* (Oberd. et all. 1967) Müller et Görs 1969, *KOELERIO GLAUCAE-CORYNEPHORETEA CANESCENTIS* Klika in Klika et Nowak 1941, and *BIDENTETEA TRIPARTITI* R. Tx., Lohm. et Prsg 1950 (Table 2, 3).

Table 2

Communities of weeds from the class *STELLARIETEA MEDIAE* in cereals

Cropping systems	Monoculture							Crop rotation						
Years	1988-1992	1992-1996	1997-2000	2000-2004	2005-2008	2009-2012	Constancy degree	1988-1992	1992-1996	1997-2000	2000-2004	2005-2008	2009-2012	Constancy degree
Crops	Winter triticale		Spring triticale	Winter wheat	Spring wheat			Winter triticale		Spring triticale	Winter wheat	Spring wheat		
1	2		3	4	5		6	7		8	9	10		11
Ch.sp. Ass. ***Apero spica – venti -Papaveretum rhoeadis***														
Anagallis arvensis L.	+	+	+	+	+	+	V	-	+	-	-	r	-	II
Apera spica-venti (L.) Beauv.	2	3	-	2	-	+	IV	1	2	-	+	+	-	IV
Papaver rhoeas L.	1	+	-	2	2	2	V	+	+	-	+	2	-	IV
D. sp. Cl.: a – *STELLARIETEA MEDIAE; b – Centauretalia cyani; c – Aperion spicae-venti; d –Aphanenion arvensis; e –Papaverion rhoeadis; f – Caucalidion lappulae ; g – Polygono-Chenopodietalia; h – Polygono-Chenopodion; i – Sisymbrietalia, Sisymbrion officinalis*														
a Fallopia convolvulus (L.) A.Löve	1	1	1	1	2	1	V	2	2	2	2	2	-	V
a Galeopsis tetrahit L.	-	-	-	-	+	1	II	-	-	-	-	2	-	I
a Lapsana communis L.	+	r	-	-	-	1	III	-	-	-	-	-	-	-
a Myosotis arvensis (L.) Hill	+	r	-	+	-	-	III	-	+	-	-	-	-	I
a Raphanus raphanistrum L.	-	-	-	-	-	-	-	-	-	-	-	+	-	I
a Stellaria media (L.) Vill.	2	2	2	2	2	+	V	2	2	-	2	2	-	IV
a Thlaspi arvense L.	+	-	-	-	+	-	II	-	-	-	-	1	-	I
a Viola arvensis Murray	2	2	1	2	+	+	V	2	2	-	2	+	-	IV
b Anthemis arvensis L.	1	+	-	-	+	-	III	+	-	-	r	+	-	III
b Buglossoides arvensis (L.) I. M. Johnston	-	-	-	-	-	-	-	+	-	-	-	-	-	I
b Consolida regalis S.F.Gray subsp. regalis	1	2	2	3	+	-	V	1	1	-	+	2	1	V
b Vicia villosa Roth	-	-	-	+	-	-	I	r	-	-	+	+	-	III
d Matricaria perforata Mérat	-	+	-	+	-	+	III	+	r	-	2	-	-	III
d Veronica hederifolia L. subsp. hederifolia	-	-	-	r	-	-	I	+	-	-	-	-	-	I
f Avena fatua L.	+	-	2	-	2	2	IV	+	+	-	-	2	3	IV
g Atriplex patula L.	-	-	-	-	-	-	-	-	-	-	-	r	-	I
g Capsella bursa-pastoris (L.) Medicus	+	+	-	+	-	-	III	+	r	-	-	1	2	IV
g Echinochloa crus-galli (L.) Beauv.	-	-	-	-	1	-	I	-	-	2	-	-	1	II
g Geranium pusillum L.	+	-	-	-	-	-	I	+	r	-	-	-	1	III
g Chenopodium album L.	2	1	-	2	2	+	V	+	2	3	2	2	-	IV
g Setaria pumila (Poiret) Schultes	-	-	-	r	-	+	II	-	-	-	-	-	-	-
g Solanum nigrum L.	-	r	-	-	-	1	II	-	-	-	-	-	-	-
g Sonchus arvensis L. subsp. arvensis	-	-	-	-	+	-	I	-	-	-	-	-	-	-
h Euphorbia helioscopia L.	-	-	+	-	+	+	III	-	-	-	-	+	2	II
h Fumaria officinalis L. subsp. officinalis	+	r	-	r	+	+	V	-	-	-	-	r	1	II
h Galinsoga parviflora Cav.	-	-	-	-	-	-	-	-	r	-	-	+	-	II
h Lamium amplexicaule L.	+	+	-	+	+	+	V	-	+	+	+	+	1	V

End of Table. 2

1	2		3	4	5		6	7		8	9	10		11
h Lamium purpureum L.	+	-	-	+	-	-	II	-	r	-	+	-	-	II
h Sonchus asper (L.) Hill	+	+	2	-	+	+	V	-	+	3	+	+	-	IV
h Sonchus oleraceus L.	+	-	-	+	+	-	III	+	2		+	r	-	IV
h Veronica persica Poiret	+	+	+	1	r	2	V	2	1	2	2	+	1	V
i Erigeron canadensis L.	-	-	-	-	-	-	-	-	r	-	-	-	-	I
Number of species	21	18	9	19	19	18	-	17	20	6	15	22	9	-

Table 3

Communities of weeds from the other classes in cereals

Cropping systems	Monoculture							Crop rotation						
Years	1988-1992	1992-1996	1997-2000	2000-2004	2005-20 08	2009-2012	Constancy degree	1988-1992	1992-1996	1997-2000	2000-2004	2005-2008	2009-2012	Constancy degree
Crops	Winter triticale		Spring triticale	Winter wheat	Spring wheat			Winter triticale		Spring triticale	Winter wheat	Spring wheat		
1	2		3	4	5		6	7		8	9	10		11
D.sp.Cl.: *a - ARTEMISIETEA VULGARIS; b – ARTEMISIENEA VULGARIS; c – GALIO-URTICENEA*														
a Cirsium arvense (L.) Scop.	1	+	-	+	+	-	IV	-	r	-	-	+	-	II
b Melandrium album (Mill.) Garcke	1	2	-	+	+	-	IV	2	1	-	2	+	-	IV
c Galium aparine L.	2	2	2	2	2	2	V	2	2	2	2	2	-	V
D. sp. Cl.: *a – MOLINIO-ARRHENATHERETEA; b – Plantaginetalia majoris, Poligonion avicularis; c – Arrhenatheretalia*														
a Plantago lanceolata L.	-	-	-	-	-	-	-	-	r	-	+	+	-	III
b Plantago major L.	-	-	-	-	-	-	-	+	-	-	-	+	-	II
b Poa annua L.	+	-	-	-	+	-	II	+	-	-	r	1	-	III
b Polygonum aviculare L.	1	+	+	-	+	+	V	+	+	-	1	+	-	IV
c Taraxacum officinale Weber in Wiggers	-	-	-	-	-	+	I	-	-	-	-	-	-	-
D. sp. Cl.: *a – AGROPYRETEA INTERMEDIO-REPENTIS, Agropyretalia intermedio-repentis, Convolvulo-Agropyrion repentis*														
a Convolvulus arvensis L.	+	+	-	-	r	-	III	-	-	-	-	-	-	-
a Elymus repens (L.) Gould	2	+	+	+	+	1	V	+	+	-	-	-	-	II
D.sp.Cl.: *a – KOELERIO GLAUCAE-CORYNEPHORETEA CANESCENTIS, Corynephoretalia canescentis*														
a Arenaria serpyllifolia L.	+	+	-	-	-	-	II	+	r	-	-	-	-	II
D.sp.Cl.: *a – BIDENTETEA TRIPARTITI, Bidentetalia tripartiti*														
a Polygonum lapathifolium L.	-	-	-	-	-	-	-	+	-	-	-	-	-	I
Other														
Amaranthus retroflexus L.	-	-	-	-	2	2	III	-	-	2	-	2	2	III
Erodium cicutarium (L.) L'Hér.	-	-	-	-	-	-	-	-	-	-	-	r	2	II
Veronica arvensis L.	+	-	-	-	-	-	I	-	-	-	-	-	-	-
Number of species	9	7	3	4	8	5	-	8	7	2	5	9	2	-

The class *STELLARIETEA MEDIAE* R.Tx., Lohm. et Prsg 1950 covers anthropogenic communities of arable fields and annual plants of ruderal areas. Three orders were distinguished in this class: *Centauretalia cyani, Polygono-Chenopodietalia* and *Sisymbrietalia*. The following alliances were identified in the order *Centauretalia cyani: Aperion spicae-venti, Papaverion rhoeadis, Caucalidion lappulae.* In turn, *Polygono-Chenopodion* alliance was identified in the order *Polygono-Chenopodietalia*, and *Sisymbrion officinalis* alliance in the order *Sisymbrietalia* (Table 2).

In the first years (1988-1992) of spring triticale monoculture, there occurred 21 species of weeds with predominating species including: *Stellaria media* (L.)

Vill., *Viola arvensis* Murray, *Apera spica-venti* (L.) Beauv., and *Chenopodium album* L. In the years 1992-1996 analyses showed 18 species of weeds in this class, with the prevailing species including: *Apera spica-venti*, Stellaria media, *Viola arvensis*, and *Consolida regalis* S.F.Gray subsp. *regalis*. In the subsequent years of the monoculture (1996-2000), spring triticale was sown instead of winter triticale. In this monoculture, analyses demonstrated 9 species, with the most abundant ones including: *Stellaria media, Consolida regalis* subsp. *regalis, Avena fatua* L., and *Sonchus asper* (L.) Hill. In 2000-2004 spring triticale was replaced by winter wheat, which increased the number of weed species to 19. The prevailing species of this cycle of monoculture included: *Consolida regalis* subsp. *regalis* (Fig. 3), *Stellaria media, Viola arvensis, Apera spica-venti*, *Papaver rhoeas* L., and *Chenopodium album*. In the years 2004-2008 spring wheat was sown in the monoculture. In that period, 19 weed species occurred that were predominated by *Fallopia convolvulus* (L.) A. Löve, *Stellaria media, Papaver rhoeas, Avena fatua* (Fig. 4), and *Chenopodium album*. In the last cycle of the cereal monoculture analyses showed 18 weed species with predominating: *Papaver rhoeas, Avena fatua*, and *Veronica persica* Poiret. In the cereal monoculture, the highest constancy of occurrence (V constancy degree) was determined for: *Anagallis arvensis* L., *Fallopia convolvulus, Stellaria media, Viola arvensis, Consolida regalis* subsp. *regalis, Papaver rhoeas* (Fig. 5), *Chenopodium album, Veronica persica, Fumaria officinalis* L., *Lamium amplexicaule* L., and *Sonchus asper.*

In the first crop rotation (1988-1992), winter triticale was infested by 17 weed species, with the dominant ones including: *Fallopia convolvulus, Stellaria media, Viola arvensis*, and *Veronica persica*. In the second crop rotation (1992-1996), 20 weed species occurred and their most abundant representatives included: *Fallopia convolvulus, Stellaria media, Viola arvensis, Apera spica-venti, Chenopodium album*, and *Sonchus oleraceus* L. In the successive study years (1996-2000) winter triticale was replaced by spring triticale. As a consequence, 6 species of weeds occurred on these plots, with dominant species including: *Chenopodium album, Sonchus asper, Fallopia convolvulus, Echinochloa crus-galli* (L.) Beauv., and *Veronica persica*. In the years 2000-2004, plots of winter wheat were infested by 15 weed species with the dominant ones including: *Fallopia convolvulus, Stellaria media, Viola arvensis, Matricaria perforata* Mérat, *Chenopodium album*, and *Veronica persica*. In the subsequent crop rotation (2004-2008), 22 species of weeds were identified in plots with spring wheat, with the most abundant ones including: *Fallopia convolvulus, Galeopsis tetrahit* L., *Stellaria media, Consolida regalis* subsp. *regalis, Papaver rhoeas, Avena fatua*, and *Chenopodium album*. In the last crop rotation (2008-2012), 9 species of weeds occurred in spring wheat, including: *Avena fatua, Capsella bursa-pastoris* (L.) Medicus and *Euphorbia helioscopia* L. as the dominant species. The highest phytosociological constancy (V degree of constancy) was determined for: *Fallopia convolvulus, Consolida regalis* subsp. *regalis, Lamium amplexicaule*, and *Veronica persica.*

Fig. 3. *Consolida regalis* S.F.Gray subsp. regalis (characteristic species *Centauretalia cyani*) in winter wheat monoculture (Photo by A. Woźniak)

Fig. 4. *Avena fatua* L. (characteristic species *Caucalidion lappulae*) in spring wheat monoculture (Photo by A. Woźniak)

Fig. 5. *Papaver rhoeas* L. (characteristic species *Apero spica – venti-Papaveretum rhoeadis*) in winter wheat (Photo by A. Woźniak)

The class *ARTEMISIETEA VULGARIS* Lohm. Prsg et R.Tx. 1950 covers nitrophilic communities of perennial plants and climbing plants on ruderal habitats. Two sub-classes were distinguished in this class: *ARTEMISIENEA VULGARIS* and *GALIO-URTICENEA* (Table 3).

In the first and second cycle of winter triticale monoculture (1988-1992 and 1992-1996) 3 weed species occurred: *Galium aparine* L., *Cirsium arvense* (L.) Scop. and *Melandrium album* (Mill.) Garcke. In the successive cycle (1996-2000), only *Galium aparine* occurred in spring triticale, whereas in the subsequent years (2000-2004) with winter wheat three species were identified *Galium aparine, Cirsium arvense*, and *Melandrium album*. The same species occurred also in the successive cycle (2004-2008) of spring wheat monoculture, whereas in the subsequent years (2008-2012) only *Galium aparine* was detected. These species occurred in the V and IV degree of phytosociological constancy. In the first and second crop rotation (1988-1992 and 1992-1996) plots with winter triticale were infested with 2-3 species of weeds. In the successive crop rotation (1996-2000), spring triticale was infested only by *Galium aparine*. In the winter wheat sown in crop rotation (2000-2004) there occurred *Melandrium album* and *Galium aparine,* whereas in spring wheat (2004-2008) – additionally *Cirsium arvense*. In the last crop rotation (2008-2012) no weeds belonging to this phytosociological class were detected in the agrocenosis. A higher constancy degree was noted for *Galium aparine* (V) and *Melandrium album* (IV), whereas a lower degree for *Cirsium arvense* (II).

In the class *MOLINIO-ARRHENATHERETEA* R. Tx. 1937 (1970) two orders were distinguished: *Plantaginetalia majoris* and *Arrhenatheretalia*. In turn, in the order *Plantaginetalia majoris*, the *Poligonion avicularis* association was distinguished (Table 3). In the first cycle of winter triticale monoculture (1988-1992) there occurred two weed species: *Polygonum aviculare* L. and *Poa annua* L., whereas in the second cycle (1992-1996) only *Polygonum aviculare*. Only the latter species occurred also in spring triticale (1996-2000). No weeds of this phytosociological class were detected in winter wheat (2000-2004). Whereas plots of spring wheat (2004-2008) were infested by *Poa annua* L. and *Polygonum aviculare*, and the successive cycle of the monoculture (2008-2012) – by *Taraxacum officinale* Weber in Wiggers and *Polygonum aviculare*. The highest degree of phytosociological constancy was determined for *Polygonum aviculare* (V degree).

In the first crop rotation (1988-1992) in winter triticale there occurred *Plantago major* L., *Poa annua* and *Polygonum aviculare*, whereas in the successive crop rotation (1992-1996) *Plantago lanceolata* L. and *Polygonum aviculare*. No weeds of this class were identified in spring triticale (1996-2000). In plots of winter wheat (2000-2004) analyses showed the presence of *Plantago lanceolata, Poa annua* and *Polygonum aviculare*. In the successive crop rotation (2004-2008), 4 weed species occurred in spring wheat: *Plantago lanceolata, Plantago major, Poa annua* and *Polygonum aviculare*, whereas no weeds representing this phytosociological class were detected in the years 2008-2012. The highest phytosociological consistency (IV degree) was determined for *Polygonum aviculare.*

The class *AGROPYRETEA INTERMEDIO-REPENTIS* Müller et Görs 1969 covers xerothermal communities with rhizomatous and runner plants predominated by *Elymus repens* (L.) Gould. The order *Agropyretalia intermedio-repentis* and the alliance *Convolvulo-Agropyrion repentis* were distinguished in this class (Table 3). In the first (1988-1992) and second (1992-1996) cycle of winter triticale monoculture two weed species occurred, namely: *Elymus repens* and *Convolvulus arvensis* L. In spring triticale (1996-2000) and in the successive cycle of winter wheat monoculture (2000-2004) analyses showed only the presence of *Elymus repens*. In turn, in the monoculture of spring wheat (2004-2008) there occurred *Elymus repens* and *Convolvulus arvensis*, whereas in the next cycle of monoculture (2008-2012) only *Elymus repens*. The highest occurrence consistency (V degree) was determined for *Elymus repens.* In the crop rotation, this phytosociological class was represented only by *Elymus repens* that occurred in winter triticale.

In the class *KOELERIO GLAUCAE-CORYNEPHORETEA CANESCENTIS* Klika in Klika et Nowak 1941 the order *Corynephoretalia canescentis* was distinguished (Table 3). The sole representative of this class was *Arenaria serpyllifolia* L., which occurred only in two cycles of winter triticale monoculture (1988-1992 and 1992-1996) and in two crop rotations. In both cases, this species occurred in the II degree of phytosociological consistency.

The class *BIDENTETEA TRIPARTITI* R. Tx., Lohm. et Prsg 1950 covers moderately nitrophilic communities of therophytes. The order *Bidentetalia tripartiti* was distinguished in this class (Table 3). In our study, its only representative was *Polygonum lapathifolium* L. which occurred only in winter triticale sown in the first crop rotation (1988-1992).

Other species. Also *Amaranthus retroflexus* L. was identified in this study, and its presence was detected in spring wheat sown in the monoculture and crop rotation as well as in spring triticale sown in crop rotation. In addition, analyses showed the presence of *Erodium cicutarium* (L.) L'Hér. in spring wheat grown in crop rotation and *Veronica arvensis* L. in the first cycle of winter triticale monoculture (1988-1992).

Discussion. The formation of weed communities in crop agrocenonses results from the co-effects of agricultural practices, soil properties and hydrothermal conditions of the habitat [16]. In the reported 24-year field experiment, weeds belonging to six phytosociological classes were identified in cereals, namely: *STELLARIETEA MEDIAE, ARTEMISIETEA VULGARIS, MOLINIO-ARRHENATHERETEA, AGRO-PYRETEA INTERMEDIO-REPENTIS, KOELERIO GLAUCAE-CORYNEPHORETEA CANESCENTIS,* and *BIDENTETEA TRIPARTITI*. Taking into consideration that the study was conducted in the region of Polesie, it is logical that species occurring therein form the class *STELLARIETEA MEDIAE*, which combines annual and two-year synanthropic weeds and these

of the ruderal areas [26]. Syntaxonomic properties of such communities are determined not only by soil fertility and species of grown plants, but also by plants succession in crop rotation.

The order *Centauretalia cyani* (Ch.sp. Ord. *Agrostemma githago* L., *Anthemis arvensis* L., *Bromus arvensis* L., *B. secalinus* L., *Centaurea cyanus* L., *Consolida regalis* subsp. *regalis, Buglossoides arvensis* (L.) I.M.Johnston, *Lolium temulentum* L., *Odontites verna* (Bellardi) Dumort. subsp. *serotina* (Dumort.) Corb., *Vicia sativa* L., *V. villosa* Roth) covers a group of segetal plants in cereals [11]. In turn, the alliance *Aperion spicae-venti* and sub-alliance *Aphanenion arvensis* (Ch.sp.Sall. *Arabidopsis thaliana* (L.) Heynh. in Holl et Heynh., *Arthemis arvensis* L., *Matricaria perforata* Mérat, *Veronica hederifolia* L. subsp. *hederifolia*) combine agrophytocenoses of cereals on richer clay soils.

The alliance *Papaverion rhoeadis* (Ch.sp.All. *Papaver rhoeas*) includes agrophytocenoses of cereals on grey forest soils.

The alliance *Caucalidion lappulae* (Ch.sp.All. *Aethusa cynapium* L., *Avena fatua, Euphorbia exigua* L., *Ranunculus arvensis* L., *Stachys annua* (L.) L.) covers agrophytocenoses of cereals on lime soils [11].

The order *Polygono-Chenopodietalia* (Ch.sp.Ord. *Atriplex patula, Alopecurus myosuroides, Capsella bursa-pastoris, Chenopodium album, Echinochloa crus-galli, Geranium pusillum* L., *Setaria pumila* (Poiret) Schultes, *Solanum nigrum* L., *Sonchus arvensis* L. subsp. *arvensis*) is an agrocenosis of weeds of the root plants. In the order *Polygono-Chenopodietalia* there was distinguished the alliance *Polygono-Chenopodion* (Ch.sp. All. *Euphorbia helioscopia* L., *Galinsoga parviflora* Cav., *Lamium purpureum* L., *Sonchus asper* (L.) Hill, *S. oleraceus* L., *Veronica persica* Poiret, *Xanthoxalis fontana* (Bunge) Holub) which includes associations of weeds of the root plants on fertile and well-moistened soils [11].

The order *Sisymbrietalia* and the alliance *Sisymbrion officinalis* (Ch.sp.Ord., All. *Bromus sterilis* L., *B. tectorum* L., *Atriplex nitens* Schkuhr, *A. tatarica* L., *Bryum argenteum* Hedw., *Chenopodium opulifolium* Schrader ex Koch et Ziz, *Ch. polyspermum* L., *Ch. rubrum* L., *Descurainia sophia* (L.) Schur, *Erigeron canadensis* L., *Lactuca serriola* L., *Lepidium ruderale* L., *Malva neglecta* Wallr., *M. pusilla* Sm., *Marchantia polymorpha* L., *Senecio viscosus* L., *Sisymbrium loeselii* L., *S. officinale* (L.) Scop., *Tussilago farfara* L., *Urtica urens* L., *Xanthium strumarium* L.) combine communities of annual and two-year synanthropic plants which represent the early stages of colonization of barren lands and abandoned gardens, but still are inferior to phytocenoses of perennial weeds [11]. They constitute the basic dynamic complexes that may be described as the first stage of formation of ruderal communities from the class *ARTEMISIETEA VULGARIS* (Table 3).

The highest number of weed species occurred in the class *STELLARIETEA MEDIAE*. Weeds included into this class represent anthropogenic species of arable lands and annual plants of ruderal areas. In the cereal monoculture, the following weed species occurred in the highest degree of phytosociological consistency (V degree): *Anagallis arvensis, Fallopia convolvulus, Stellaria media, Viola arvensis, Consolida regalis* subsp. *regalis, Papaver rhoeas, Chenopodium album, Fumaria officinalis, Lamium amplexicaule, Sonchus asper*, and *Veronica persica*. In the IV degree of phytosociological consistency there occurred *Apera spica-venti* and *Avena fatua*. In the crop rotation, the highest degree of consistency (V degree) was determined for: *Fallopia convolvulus, Consolida regalis* subsp. *regalis, Lamium amplexicaule*, and *Veronica persica*, whereas the IV degree for: *Stellaria media, Viola arvensis, Apera spica-venti, Papaver rhoeas, Avena fatua, Capsella bursa-pastoris, Chenopodium album, Sonchus asper,* and *Sonchus oleraceus*. The occurrence of these weed species in cereals results form the presence of their seeds in soil. These correlations were confirmed in a study by Woźniak [21].

The analysis of experimental materials demonstrated that the *Apero spica-venti-Papaveretum rhoeadis* V.Sl. 1987 association was formulated in most cycles, its syntaxonomic affiliation is as follows: CL. *STELLARIETEA MEDIAE* R.Tx., Lohm. et Prsg, 1950, Ord. *Centauretalia cyani* R.Tx. 1950, All. *Papaverion rhoeadis* V.Sl. 1987, Ass. *Apero spica-venti-Papaveretum rhoeadis* V.Sl.1987 (Ch.sp.Ass. *Apera spica-venti, Papaver rhoeas, Anagallis arvensis*).

The association *Apero spica-venti-Papaveretum rhoeadis* V.Sl.1987 is a widespread ecological community of cereal weeds, especially of rye and wheat. In the floristic composition, the predominating species almost always include these of the *STELLARIETEA MEDIAE* and *MOLINIO-ARRHENATHERETEA* classes. As reported, this association is linked with winter cereals and for this reason in crops of spring cereals it is characterized by incomplete composition of characteristics species or with their smaller contribution in the composition (Table 2, cycles 1996-2000, 2004-2008, 1996-2000, 2008-2012).

In the case of our study, it turned out that the species composition of this association was somehow untypical to the cereal agrocenosis, because its composition included many species of the order *Polygono-Chenopodietalia* of the alliance *Polygono-Chenopodion*, that are characteristic to the root plants. Untypical is also another moment, fixed in the study, namely the formation in cereal crops of complex communities composed of species typical of different associations of the class *STELLARIETEA MEDIAE*, and also sometimes associations of various classes.

In summary, it ought to be concluded that the phytosociological and syntaxonomic evaluation of weed communities was based on multiple observations conducted in the vegetative season. Results achieved in the study demonstrated that both in the monoculture and in crop rotation the formation of associations of segetal weeds followed the scheme being typical of cereal crops and included that formation of the *Apero spica-venti-Papaveretum rhoeadis* V.Sl.1987 association characteristics of cereal agrocenoses. In spite of that, in both systems (i.e. in the monoculture

and in crop rotation), the formed communities of weeds contained a high number of species characteristic to the root plants. It may be hypothesized that it results from the adopted agricultural practice which assumes the use of manure once in the rotation (every 4 years). In our field experiment, manure was applied 6 times on all plots and thus significantly increased the seedbank of weeds in the soil [14]. It may be speculated that it had a significant impact on the phytosociological and syntaxonomic evaluation of weed communities in cereal monoculture and crop rotation. Taking into account the presented arguments, in the syntaxonomic evaluation of cereal monocultures consideration should also be given to new communities of segetal weeds, which we tried to demonstrate in this work.

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СИНТАКСОНОМІЧНА ОЦІНКА УГРУПОВАНЬ БУР'ЯНІВ У АГРОЦЕНОЗАХ ЗЕРНОВИХ

Зроблено фітосоціологічний та синтаксономічний аналіз сегетальних угруповань у монокультурі зернових і сівозміні. В угрупованнях бур'янів ярих та озимих зернових в монокультурі і сівозміні було виділено види з шести синтаксономічних класів: *STELLARIETEA MEDIAE* R.Tx, Lohm. et Prsg 1950, *ARTEMISIETEA VULGARIS* Lohm. Prsg et R.Tx. 1950, *MOLINIO-ARRHENATHERETEA* R. Tx. 1937 (1970), *AGROPYRETEA INTERMEDIO-REPENTIS* (Oberd. et all. 1967) Müller et Görs 1969, *KOELERIO GLAUCAE-CORYNEPHORETEA CANESCENTIS* Klika in Klika et Nowak 1941 і *BIDENTETEA TRIPARTITI* R. Tx., Lohm. et Prsg 1950. Результати показали, що в монокультурі і в сівозміні формування комплексів сегетальних бур'янів проходило відповідно до схеми, типової для зернових культур. Тим не менше, в обох системах землеробства зернових утворилися угруповання бур'янів з великою часткою видів, характерних для просапних культур.

Ключові слова: синтаксономія, видове різноманіття, сівозміна, монокультура, бур'яни

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СИНТАКСОНОМИЧЕСКАЯ ОЦЕНКА СООБЩЕСТВ СОРНЯКОВ В АГРОЦЕНОЗАХ ЗЕРНОВЫХ

Проведены фитосоциологический и синтаксономический анализы сегетальных сообществ в монокультуре зерновых и севообороте. В сообществах сорняков яровых и озимых зерновых в монокультуре и севообороте были выделены виды из шести синтаксономических классов: *STELLARIETEA MEDIAE* R.Tx, Lohm. et Prsg 1950, *ARTEMISIETEA VULGARIS* Lohm. Prsg et R.Tx. 1950, *MOLINIO-ARRHENATHERETEA* R. Tx. 1937 (1970), *AGROPYRETEA INTERMEDIO-REPENTIS* (Oberd. et all. 1967) Müller et Görs 1969, *KOELERIO GLAUCAE-CORYNEPHORETEA CANESCENTIS* Klika in Klika et Nowak 1941 і *BIDENTETEA TRIPARTITI* R. Tx., Lohm. et Prsg 1950. Результаты показали, что в монокультуре и севообороте формирование комплексов сегетальных сорняков проходило согласно схеме, типичной для зерновых культур. Тем не менее, в обеих системах земледелия зерновых образовались сообщества сорняков с большой долей видов, характерных для пропашных культур.

Ключевые слова: синтаксономия, видовое разнообразие, севооборот, монокультура, сорняки