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Weed flora in the agro-ecosystems of Eastern Europe: a case study of the Lipetsk region, Russian federation

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Abstract

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Global climate change entails changes in the plant species composition in different areas. From this perspective, both need monitoring, this study uses a modern scientific approach to the concept of "weed" and "agroecosystem" to explore the current species composition of agroecosystems' weeds of the Lipetsk region, Russian Federation. The research framework includes field data on ruderal and segetal communities. Data collection sites are farms. Information gathering embraces weed taxonomy, floristic diversity and species frequency. A comparative analysis of these data allows finding similarities and differences in weed species composition between different habitats.

Keywords: weeds; agroecosystem; phytosanitary certification; segetal habitats; ruderal habitats; species composition; floristic analysis

Introduction

Weeds are serious competitors of cereals in the acquisition nutrient (Glowacka, 2011) and light, which chlorophyll fluorescence measurements confirm (Zhang et al., 2019). Those weeds growing in agro-ecosystems are crop-specific, which means they are associated with a specific crop and do not grow in other areas (Gabitov et al., 2018; Rakhimov et al., 2018). Each crop characterized by a specific set of related weeds. *Echinochloa crus-galli* (L.) *Beauv* and *Setaria spp* are associated with corn (Von Redwitz & Gerowitt, 2018). In fields under *Triticum aestivum* common wheat weed diversity is higher but abundance is reduced (Petit et al., 2016). A wide spectrum of weeds grows in fields under *Lotus corniculatus L.* (bird's-foot trefoil). By contrast in the mix of *Pisum sativum L. (*peas*) Onobrychis viciifolia Scop.* (sainfoin) creates a plant community with a minimum number of weed species (Marinov-Serafimov et al., 2019).

The ruderal community structure is analysed on four weed metrics species richness, density, biomass and seed rain (Alignier et al., 2017). There are several ways to determine Shannon-Wiener's diversity index for ruderal species (e.g. by gravimetric analysis at the tillering stage, by weight measurement at the waxy maturity stage of crop (Woźniak, 2019), by Braun-Blanquet analysis (Dąbkowska et al., 2017). Methods to estimate weed diversity and density (i.e germinable seed bank (GSB) method and extractable seed bank method (ESB)) provide different quantifications (Reinhardt & Leon, 2018), while that Shannon-Wiener's diversity index and Simpson's index of dominance are equivalent. However, the latter statement is true for measurements made at the tillering stage – at later phonological stages, they provide different data

(Lugowska & Rzymowska, 2014). This contradiction arises from the relationship with pH and soil texture (Lugowska et al., 2016). There is a study using three methods – the Two-way Indicator Species Analysis (TWINSPAN), Detrended Correspondence Analysis (DCA) and Redundancy Analysis (RDA) – in combination to track changes in the ruderal weed species composition. There is experience using several analyses (TWINSPAN, DCA and RDA) to study the change in the species composition of the ruderal field weeds in time (Nie et al., 2018). With a multi-wavelength laser line profile system, some researchers determine the degree of weed infestation by the nature of the field surface (Strothmann et al., 2017).

Within one country, the species composition of ruderal plant communities varies greatly by region and districts (Schumacher et al., 2018). The phenotypic plasticity of weeds species is also a chargeable property, which varies from site to site (Montesinos & Callaway, 2018). The most visible changes in the ruderal species composition occur in fields under corn during vegetation (Rahayu et al., 2018). Weed species composition is constantly changing under the influence of various environmental factors. Nitrogen and phosphorus together with water and loam enhance the richness of ruderal species (Rostami et al., 2016). Soil properties were used as a reference to build a model of within-field distribution for *Alopecurus myosuroides Huds* (blackgrass) in England (Metcalfe et al., 2019), while in China, such a model was created for *Scirpus mariqueter Tang* (sea bulrush) (Li et al., 2018). Blackgrass and sea bulrush are common weeds in England and China, so they are not questionable choices. According to Shannon-Wiener's diversity index and Simpson's index of dominance, influencing the specific gravity of one particular species is technically easier than influencing the entire weed community (Hofmeijer & Gerowitt, 2018).

Climate warming promotes the spreading of southern (ruderal and segetal) species to the north and outside agricultural fields their introduction into communities of secondary soil of agroecosystems (Houngbédji et al., 2016). Among meteorological factors, weed species composition correlates best with wind (Ianovici, 2016), since seeds are carried to various distances by wind (Liu et al., 2018). Vernalisation in weeds is associated with the latitude (Darmency et al., 2016).

This study defines a "weed plant" as (1) a factor reducing crop yield and quality, and (2) a member of a special ecological group growing in areas disturbed by agricultural activity but not used for agricultural purposes (e.g. roads through fields). Agroecosystems are crop-rotation systems, grazing lands, fallow fields, lands being cultivated for different periods of time, and ruderal habitats. Increasing plant composition ensures the stability and constancy of any ecosystem increases with the number of plant species increase in it (Isbell et al., 2017).

In this regard, the relevance of the research highlighted below is beyond doubt. Changes in weed species composition leads to the systems of crops protecting change. Based on this, the aim of the work is to study the modern species composition of weeds in the agroecosystems of Eastern Europe (a case of study of Lipetsk region, Russian Federation).

Material and Methods

The object of the research is the weed species composition of segetal and ruderal habitats of agroecosystems, in Lipetsk region. We combined all the secondary soils of agroecosystems, except segetal, into a complex group called "ruderal" to simplify the matter. The materials of the study are the field reconnaissance data of segetal (171 fields) and ruderal (290 plots) habitats of Lipetsk region agroecosystems, carried out in 2016–2018. The surveys were conducted on 15–20 control areas with 1 m^2 each within each part or field. Segetal habitats were examined according to the geobotanical prospecting method. Ruderal fields were examined according to the method of studying weeds' prevalence. The identification of weed species was carried out in the traditional botanical way by total morphological character.

The taxonomic composition of various field weeds was revealed by the method of floristic analysis. Floristic richness (the number of species in the sample) and systematic diversity (distribution of species by taxa of different ranks) were reviled only by the presence (absence) of the species in the plant community, in spite of its abundance. The analysis used the concept of the floristic spectrum: the composition and gradation of 10-15 leading families according to the number of species they include. The evaluation of the weed species representation was carried out according to the frequency classes method by the Kazantsev, which is identical to the Braun-Blanquet analysis: when the specie registered within the area for 81-100% this is class V; 61-80% – class IV; 41-60% – III class; 21-40% – class II; up to 20% – class I. The assessment of species similarity of different field was carried out according to Jaccard's coefficient of community. The names of the species are given in accordance with the modern botanical nomenclature (McNeill et al., 2012).

Results and Discussion

Results

274 weed species were recorded in the segetal and ruderal fields, in total, belonging to 169 genera and 34 families located in Lipetsk region agroecosystems. Taxonomic analysis of the segetal and ruderal components of the flora as a whole (Table 1), as well as among families (Table 2) revealed that the values of floristic richness and systematic diversity of the ruderal components in all positions are higher than the segetal.

Table 1. Systematic diversity of segetal and ruderal communities (Lipetsk region, 2016 – 2018)

Indicators	Habitat type	
	Segetal	Ruderal
Quantity of families	27	34
Quantity of genera	85	163
Quantity of species	117	251
Average quantity of species and families	4.46	7.38
Average quantity of genera and families	3.23	4.79
Average quantity of species among a genus	1.38	1.54

Despite the significant difference in the number of species among 10 leading families (92 segetal and 192 ruderal components), the rate of ruderal and segetal species in flora is about the same: 78.63% and 76.49%, respectively. The rate of other families (with 1-2 species) is 62.96% in the segetal and 38.89% in the ruderal communities. By the number of species, the ruderal communities mainly occur in first 10 leading families, the segetal ones – in the first 8 families. The average number of species among a genus ranges from 1.00 to 5.00 in the ruderal communities, and from 1.14 to

Table 2. Floristic richness and systematic diversity of segetal and ruderal communities of the complex of families (Lipetsk region, 2016 – 2018)

Name of the family	Quantity of species		Quantity of genera		Average quantity of species among a family's genus	
	Segetal	Ruderal	Segetal	Ruderal	Segetal	Ruderal
Compositae Giseke	24	55	21	34	1.14	1.62
Polygonaceaeuss.	14	10	6	5	2.33	2.00
Gramineae Juss.	10	30	9	20	1.11	1.50
Leguminosae Juss.	9	22	6	10	1.50	2.20
Cruciferae Juss.	8	20	6	17	1.33	1.18
Labiatae Juss., *nom. altern.*	8	16	4	10	2.00	1.60
Caryophyllaceae Juss.	7	9	5	7	1.40	1.29
Boraginaceae Juss. (incl. *Hydrophyllaceae* R. Br.)	5	9	5	9	1.00	1.00
Euphorbiaceae Juss.	4	4	1	1	4.00	4.00
Rubiaceae Juss.	3	5	2	1	1.50	5.00
Campanulaceae Juss. *s. l.*	2	3	1		2.00	3.00
Chenopodiaceae Vent.	2	3	1	2	2.00	1.50
Geraniaceae Juss.	2	3	1	2	2.00	1.50
Malvaceae Juss.	2	3	1	1	2.00	3.00
Plantaginaceae Juss.	2	3	1	1	2.00	3.00
Ranunculaceae Juss.	2	4	2	2	1.00	2.00
Rosaceae Adans.	2	7	2	5	1.00	1.40
Scrophulariaceae Juss. *s. l.* (incl. *Orobanchaceae* Vent.)	2	10	2	6	1.00	1.67
Amaranthaceae Juss.	2	2	1	1	2.00	2.00
Convolvulaceae Juss.	1	1	1	1	1.00	1.00
Equisetaceae Michx. *ex DC.*	1	1	1	1	1.00	1.00
Papaveraceae Juss. (incl. *Fumariaceae* DC.)	1	2	1	2	1.00	1.00
Hypericaceae Juss.	1	1	1	1	1.00	1.00
Umbelliferae Juss.	1	11	1	10	1.00	1.10
Solanaceae Juss.	1	2	1	2	1.00	1.00
Urticaceae Juss.	1	1	1	1	1.00	1.00
Violaceae Batsch	1	1	1	1	1.00	1.00
Onagraceae Juss.	–	3	–	2	–	1.50
Alliaceae Agardh s. l.	–	3	–	1	–	2.00
Cyperaceae Juss.	–	2	–	1	–	2.00
Primulaceae Vent.	–	2	–	2	–	1.00
Aceraceae Juss.	–	1	–	1	–	1.00
Cuscutaceae Dumort.	–	1	–	1	–	1.00
Dipsacaceae Juss.	–	1	–	1	–	1.00

Table 3. Floristic spectra of segetal and ruderal habitats (Lipetsk region, 2016 – 2018)

Segetal component of flora		Ruderal component of flora	
Name of the family	Quantity of species among a family	Name of the family	Quantity of species among a family
Compositae Giseke	24	*Compositae* Giseke	55
Polygonaceae Juss.	14	*Gramineae* Juss.	30
Gramineae Juss.	10	*Leguminosae* Juss.	22
Leguminosae Juss.	9	*Cruciferae* Juss.	20
Cruciferae Juss.	8	*Labiatae* Juss.	16
Labiatae Juss.	8	*Umbelliferae* Juss.	11
Caryophyllaceae Juss.	7	*Polygonaceae* Juss.	10
Boraginaceae Juss.	5	*Scrophulariaceae* Juss. s. l.	10
Euphorbiaceae Juss.	4	*Caryophyllaceae* Juss.	9
Rubiaceae Juss.	3	*Boraginaceae* Juss.	9

2.33 in the segetal ones. The floristic spectra comparison was made by comparing the first two „triads" of leading families. Fundamental botanical researches have shown that *Compositae* Giseke and *Gramineae Juss* families are compulsory components of the first "triad" in the structure of the flora on the territory of Russian. The third component of the first "triad" can be only one of the following families: *Leguminosae* Juss.*, Cyperaceae* Juss.*, Rosaceae Adans., Chenopodiaceae Vent., Cruciferae* Juss.*, Caryophyllaceae* Juss.*, Ranunculaceae* Juss.*, Labiatae* Juss.*, Scrophulariaceae Juss*. This stage of the analysis revealed significant differences in the segetal and ruderal components of floras. The composition of the first "triad" of the ruderal communities corresponds to the above regularity: besides the obligatory families *Compositae* Giseke and *Gramineae Juss,* it includes *Leguminosae Juss*. Such composition indicates a greater proximity of the ruderal habitats to the flora of natural habitats (Table 3).

The first "triad" of segetal communities includes *Polygonaceae* Juss., which is not even in the second "triad" of ruderal communities. At the same time, *Umbelliferae Juss* that belongs to the second "triad" of ruderal communities is not even among the ten leading families of segetal ones.

The gradation of identical families is not the same in the structure of the spectra, which indicates the different significance of one or another family for segetal and ruderal communities. The species number indexes (ratios) of individual pairs of families were calculated for a more objective reflection of the families influence (Table 4).

Compositae Giseke has the leading importance in the structure of segetal and ruderal communities of the Lipetsk region that is confirmed by the high indexes of the species number comparing to all families of the first two "triads". However, this indicator is higher among the ruderal communities. *Polygonaceae Juss* and *Labiatae Juss* are of high importance in the segetal habitats, and the *Gramineae Juss* – in the ruderal. *Cruciferae Juss* shows a tendency to increase in importance of the rudera communities, and *Leguminosae Juss* – in segetal.

Segetal and ruderal components of the flora include species of practically the same families, but along with, the same genera in the phytocoenosis slightly include less than half, and the same species only one third (Table 5).

The range of species similarity between rich-in-species families is relatively low. This indicates that there is a complex of identical species supplemented with species that are characteristic only for one of the habitat types – segetal or ruderal.

The evaluation of frequency for each of the registered weed species showed that the species are represented of varying degrees in different types of habitats of agroecosystems (Table 6).

Comparison of the frequency classes the same for segetal and ruderal habitats showed that the composition of species of III, IV, V classes, practically, does not coincide. The general species is present only among groups of class III (*Chenopodium album L.*). Comparison of complex groups of species of high frequency (III – V classes) demonstrated their rather low similarity (KJ = 15.38%), there are only two common types (*Convolvulus arvensis L., Chenopodium album L.*) (Fig. 1).

There are only 2 common families in groups of species of the second frequency class (*Amaranthus retroflexus L., Fallopia convolvulus* (L.) *A. Löve*).

The first class of frequency contains the largest number of species (105 species in segetal and 226 species in ruderal habitats), among them 68 species were registered in both

Table 4. Species number indexes of the two first "triads" among segetal and ruderal components of flora (Lipetsk region, 2016-2018)

Name of the family	Segetal component of flora	Name of the family	Ruderal component of flora
Compositae Giseke /*Polygonaceae* Juss.	1.71	*Compositae* Giseke / *Gramineae* Juss.	1.83
Compositae Giseke / *Gramineae* Juss.	2.40	*Compositae* Giseke / *Leguminosae* Juss.	2.50
Compositae Giseke /*Leguminosae* Juss.	2.67	*Compositae* Giseke / *Cruciferae* Juss.	2.75
Compositae Giseke / *Crucifera* Juss.	3.00	*Compositae* Giseke/ *Labiatae* Juss.	3.44
Compositae Giseke /*Labiatae* Juss.	3.00	*Compositae* Giseke/ *Umbelliferae* Juss.	5.00
Polygonaceae Juss./ *Compositae* Giseke	0.58	*Umbelliferae* Juss./ *Compositae* Giseke	0.20
Polygonaceae Juss./ *Gramineae* Juss.	1.40	*Umbelliferae* Juss./ *Gramineae* Juss.	0.37
Polygonaceae Juss./ *Leguminosae* Juss.	1.56	*Umbelliferae* Juss./ *Leguminosae* Juss.	0.50
Polygonaceae Juss./ *Cruciferae* Juss.	1.75	*Umbelliferae* Juss./ *Cruciferae* Juss.	0.55
Polygonaceae Juss./ *Labiatae* Juss.	1.75	*Umbelliferae* Juss./ *Labiatae* Juss.	0.69
Gramineae Juss./ *Compositae* Giseke	0.42	*Gramineae* Juss./ *Compositae* Giseke	0.55
Gramineae Juss./ *Polygonaceae* Juss.	0.71	*Gramineae* Juss./ *Umbelliferae* Juss.	2.73
Gramineae Juss./ *Leguminosae* Juss.	1.11	*Gramineae* Juss./ *Leguminosae* Juss.	1.36
Gramineae Juss./ *Cruciferae* Juss.	1.25	*Gramineae* Juss./ *Cruciferae* Juss.	1.50
Gramineae Juss./ *Labiatae* Juss.	1.25	*Gramineae* Juss./ *Labiatae* Juss.	1.88
Leguminosae Juss./ *Compositae* Giseke	0.38	*Leguminosae* Juss./ *Compositae* Giseke	0.40
Leguminosae Juss./ *Polygonaceae* Juss.	0.64	*Leguminosae* Juss./ *Umbelliferae* Juss.	2.00
Leguminosae Juss./ *Gramineae* Juss.	0.90	*Leguminosae* Juss./ *Gramineae* Juss.	0.73
Leguminosae Juss./ *Cruciferae* Juss.	1.13	*Leguminosae* Juss./ *Cruciferae* Juss.	1.10
Leguminosae Juss./ *Labiatae* Juss.	1.13	*Leguminosae* Juss./ *Labiatae* Juss.	1.38
Cruciferae Juss. / *Compositae* Giseke	0.33	*Cruciferae* Juss./ *Compositae* Giseke	0.36
Cruciferae Juss./ *Polygonaceae* Juss.	0.57	*Cruciferae* Juss./ *Umbelliferae* Juss.	1.82
Cruciferae Juss./ *Gramineae* Juss.	0.80	*Cruciferae* Juss./ *Gramineae* Juss.	0,67
Cruciferae Juss./ *Leguminosae* Juss.	0.89	*Cruciferae* Juss. / *Leguminosae* Juss.	0.91
Cruciferae Juss./ *Labiatae* Juss.	1.00	*Cruciferae* Juss./ *Labiatae* Juss.	1.25
Labiatae Juss./ *Compositae* Giseke	0.33	*Labiatae* Juss./ *Compositae* Giseke	0.29
Labiatae Juss./ *Polygonaceae* Juss.	0.57	*Labiatae* Juss./ *Umbelliferae* Juss.	1.46
Labiatae Juss./ *Gramineae* Juss.	0.80	*Labiatae* Juss./ *Gramineae* Juss.	0.53
Labiatae Juss./ *Leguminosae* Juss.	0.89	*Labiatae* Juss./ *Leguminosae* Juss.	0.73
Labiatae Juss./ *Cruciferae* Juss.	1.00	*Labiatae* Juss./ *Cruciferae* Juss.	0.80

types of habitats. These are segetal-ruderal and ruderal-segetal species adapted to grow in both types of habitats that helps to preserve the segetal potential of the flora. It cannot be confirmed that the species of this group for segetal habitats are absent in ruderal habitats even despite the low similarity in species of high frequency. Five out of seven species (71.43%) of the high frequency belonging to segetal habitats and also are in ruderal, but with less amount. Thus, *Echinochloa crusgalli* (L.) *Beauv., Cirsium arvense* (L.) *Scop., Viola arvensis Murray, Galium aparine L.*, moved down from III to II class, and *Galeopsis tetrahit L* from II to I (Fig. 2).

On the other hand, a number of species that belong to the classes of low frequency (class I – II) in segetal habitats are more pronounced in the ruderal habitats. Thus, *Polygonum aviculare L., Artemisia absinthium L.* moved up from I to IV class; *Tripleurospermum inodorum* (L.) *Sch. Bip., Cichorium intybus L., Artemisia vulgaris L.* – from I to III, *Capsella bursa-pastoris* (L.) *Medik.* – from II to III.

Having analysed the general list of weed species, we revealed two types of species 1) species that rarely occur and 2) introduced species. The species of the first class of frequency still do not have practical segetal potential due to their insignificant occurrence (mainly reviled 1 – 2 times). But they require attention both in the case of biodiversity conservation of the ecosystems in the region as a whole, and to study the possible process of segetalization of these species. These are the species from the Red Book of the Lipetsk region: *Allium inaequale Janka* (a vulnerable species, the number of which is constantly decreasing); *Campanula persicifolia L.* (species requiring monitoring). According to botanical reports, these are the species rarely found in the region: *Pilosella echioides (Lumn.); Euphorbia cyparissias L., Sinapis alba L., Solanum nigrum L.; Vicia villosa Roth, Helianthus lenticularis Dougl. ex Lindl* .; introduced species of North American origin are *Amaranthus blitoides S. Watson, Cyclachaena xanthiifolia (Nutt.) Fresen., Xanthium strumarium L.;* revealed the location of *Lupinus polyphyllus Lindl.* and *Herachleum sosnowskyi Manden.*, that are burdensome species for many regions of Russia.

Discussion

High rates of taxonomic similarity among the family (KJ = 79.41%) indicate that the segetal and ruderal communities include species from almost the same families, but species of the same genera in the phytocoenosis of both habitat slightly include less than a half (KJ = 46.15%), and the same species – only one third (KJ = 33.89%). According to 20-year observations of weeds, it was believed, previously, that *Poaceae, Asteraceae, Brassicaceae* and *Amaranthaceae* are the dominant families (45% of the total number of species) in the grain crops (Eddoud et al., 2018). According to our data, now only 3 families dominate in crops of cereals: *Poaceae,*

Table 5. Indicators of the similarity coefficients (KJ) of the taxonomic composition within the families of segetal and ruderal habitats (Lipetsk region, 2016–2018)

Name of the family	Quantity of species in segetal habitats	Quantity of species in ruderal habitats	Total quantity of species	Jaccard's coefficient, %
Aceraceae Juss.	–	1	–	–
Alliaceae Agardhs. l.	–	2	–	–
Amaranthaceae Juss.	2	2	1	33.33
Boraginaceae Juss. (incl. *Hydrophyllaceae* R. Br.)	5	9	5	55.56
Campanulaceae Juss. *s. l.*	2	3	0	–
Caryophyllaceae Juss.	7	9	6	60.00
Chenopodiaceae Vent.	2	3	1	25.00
Compositae Giseke	24	55	18	29.51
Convolvulaceae Juss.	1	1	1	100.00
Cruciferae Juss.	8	20	7	33.33
Cuscutaceae Dumort.	–	1	–	–
Cyperaceae Juss.	–	2	–	–
Dipsacaceae Juss.	–	1	–	–
Equisetaceae Michx. ex DC.	1	1	1	100.00
Euphorbiaceae Juss.	4	4	3	60.00
Geraniaceae Juss.	2	3	1	25.00
Gramineae Juss.	10	30	10	33.33
Hypericaceae Juss.	1	1	1	100.00
Labiatae Juss., *nom. altern.*	8	16	8	50.00
Leguminosae Juss.	9	22	8	34.78
Malvaceae Juss.	2	3	1	25.00
Onagraceae Juss.	–	3	–	–
Papaveraceae Juss. (incl. *Fumariaceae* DC.)	1	2	1	50.00
Plantaginaceae Juss.	2	3	2	66.67
Polygonaceae Juss.	14	10	6	33.33
Primulaceae Vent.	–	2	–	–
Ranunculaceae Juss.	1	4	1	25.00
Rosaceae Adans.	2	7	2	28.57
Rubiaceae Juss.	3	5	2	33.33
Scrophulariaceae Juss. *s. l.* (incl. *Orobanchaceae* Vent.)	2	10	2	20.00
Solanaceae Juss.	1	2	1	50.00
Umbelliferae Juss.	1	11	1	9.09
Urticaceae Juss.	1	1	1	100.00
Violaceae Batsch	1	1	1	100.00

Table 6. The classification of weed species' frequency in different types of habitats (Lipetsk region, 2016 – 2018)

Indicator	Segetal habitat	Ruderal habitat
V class of frequency		
Name of the species class	*Convolvulus arvensis* L.	Not reviled
Rage of habitat, where species classes occur (%)	80.93	–
Quantity of the species class	1	–
Rage of species class out of total quantity (%)	0.85	–
IV class of frequency		
Name of the species class	Not reviled	*Polygonum aviculare* L. *Artemisia absinthium* L.
Rage of habitat, where species classes occur (%)	–	67.24 – 68.97
Quantity of the species class	–	2
Rage of species class out of total quantity (%)	–	0.80
III class of frequency		
Name of the species class	*Echinochloa crusgalli* (L.) Beauv. *Chenopodium album* L. *Galeopsis tetrahit* L. *Cirsium arvense* (L.) Scop. *Viola arvensis* Murray *Galium aparine* L.	*Tripleurospermum inodorum* (L.) Sch. Bip. *Convolvulus arvensis* L. *Capsella bursa-pastoris* (L.) Medik. *Cichoriumintybus* L. Artemisia vulgaris L. *Chenopodium album* L.
Rage of habitat, where species classes occur (%)	40.00 – 59.54	42.41 – 51.72
Quantity of the species class	6	6
Rage of species class out of total quantity (%)	5.09	2.39
II class of frequency		
Name of the species class	*Amaranthus retroflexus* L. *Fallopia convolvulus* (L.) A. Löve *Melandrium album* (Mill.) Garce *Raphanus raphanistrum* L. *Capsella bursa-pastoris* (L.) Medik. *Fumaria officinalis* L.	*Amaranthus retroflexus* L. *Fallopia convolvulus* (L.) A. Löve *Elytrigia repens* (L.) Nevski *Taraxacum officinale* Wigg. *Poa pratensis* L. *Lactuca serriola* L. *Echinochloa crusgalli* (L.) Beauv. *Cirsium arvense* (L.) Scop. *Bromus secalinus* L. *Euphorbia virgata* Waldst. et Kit. *Consolida regalis* S.F. Gray *Plantago major* L. *Silene pratensis (*Rafn*)* Godr. *Festuca pratensis* Huds. *Viola arvensis* Murray *Malva pusilla* Smith. *Galium aparine* L.
Rage of habitat, where species classes occur (%)	21.39 – 36.42	21.03 – 40.69
Quantity of the species class	6	17
Rage of species class out of total quantity (%)	5.09	6.77
I class of frequency		
Name of the species class	*Sinapis arvensis* L.*, Setaria viridis* (L.) P. Beauv.*, Erigeron canadensis* L.*, Avena fatua* L.*, Centaurea cyanus* L.*, Erodium cicutarium* (L.) *L'Herit., Persicaria lapathifolia* (L.) Delabre*, Thlaspi arvense* L.*, Lappula squarrosa* (Retz.) *Dumort., Stellaria media* (L.) Vill.*, Setaria pumila* (Poir.) *Roem. et Schult., Galeopsis ladanum* L.*, Lathyrus tuberosus* L.*, Solanum nigrum* L.*, Myosotis arvensis* (L.) Hill.*, Achillea millefolium* L.*, Lamium amplexicaule* L.*, Cyclachaena xanthiifolia* (Nutt.) *Fresen., Sonchus oleraceus* L.*, Xanthium strumarium* L.*, Lycopsis arvensis* L.*, Brassica campestris* L.*, Galeopsis speciosa Mil*L.*, Sonchus arvensis* L. etc. *.	
Rage of habitat, where species classes occur (%)	0.85 – 19.10	0.34 – 20.00
Quantity of the species class	105	226
Rage of species class out of total quantity (%)	88.98	90.04

*the table shows 24 of the 68 species of the first class registered in both types of habitats

Chenopodium album L. *Convolvulus arvensis* L.

Fig. 1. Weeds species of segetal and ruderal habitats, Lipetsk region

Galium aparine L. *Viola arvensis* Murray *Galeopsis tetrahit* L.

Fig. 2. Weed species of ruderal habitats, Lipetsk region

Asteraceae and *Polygonaceae*. Using the method of intracellular markers, it was previously established that *Ambrosia artemisiifolia L* is closely associated with other genera of the *Astra* family, due to similarities in anemophily (Tomasello et al., 2019). We did not find such a connection in the ruderal and segetal habitats of the Lipetsk region. If 20 years ago, *Anthemis tinctoria L* was common in crops, especially in Slovakia (Vaverkova et al., 1999), then at the moment the segetal potential of this species has declined sharply – it practically does not occur in crops. For the first time, we found species that weren't previously recorded in botanical summaries: *Euphorbia borodinii Sambuk, Visnaga daucoides Gaertn, Centaurea iberica Trevir. ex Spreng*. Now, only *Centaurea iberica Trevir. ex Spreng* becomes a problematic weed in some areas of Iran (Nosratti et al., 2017). The possibility of dispersal of introduced species in the region requires further study.

Conclusion

The modern species composition of the agroecosystems of the studied region includes 274 weed species belonging to 169 genera and 34 families. Studies highlights that the ruderal component of the Lipetsk region flora is richer and more diverse than the segetal. The increasing diversity of plants in agroecosystems increases their resistance, especially due to the ruderal component. The range of species in the leading families is the same for both flora habitats, but for the ruderal the generic richness is higher. On average there are more species among a genus and the range of low-species families is smaller. The weed flora communities differ in the composition of the leading families, and the ruderal ones are close to the natural flora habitats according to some indicator. *Compositae* Giseke occupies the leading position in both habitats, moreover, *Polygonaceae Juss* and *Labiatae Juss* are significant in the segetal and *Gramineae Jus*s in the ruderal.

Segetal and ruderal weed floras include species from practically the same families, but only one third include identical species among communities of two habitats. The other species are characteristic only for one of the habitat – segetal or ruderal. Species occurring in 41-100% of habitats are practically different in the segetal and ruderal elements (KJ = 15.38%). The connection of two weed flora components is realized mainly through 68 species adapted to grow in both types of habitats, as well as due to a number of common species that change their position in groups of high and low frequency classes. A tendency of changing the weed species composition in the region due to the introduction of species from the southern regions has been revealed. This will lead to changes in the system of protective measures in the case of possible naturalization of new species and confirms the importance of phytosanitary monitoring in the process of studying weeds.

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