# Peculiarities in plant communities' formation in crop plantings in the south-eastern part of the Central Russian Upland

**V K Tokhtar[1], V N Zelenkova[1], E V Fomina[2] and E M Chebotaeva[3]**

[1]Belgorod State National Research University, 85, Pobedy Street, Belgorod, 308015, Russia
[2]Belgorod State Technological University named after V G Shoukhov, 46, Kostukova Street, Belgorod, 308012, Russia
[3]National Research University Moscow State University of Civil Engineering, 26, Yaroslavskoye Shosse, Moscow,129337, Russia

E-mail: fomina.katerina@mail.ru

**Abstract**. The article describes a study of plant communities of the south-western part of the Central Russian Upland that form in batches of various crops. Field studies employed the methods of reconnaissance floristic survey. Species diversity of the plant complexes and plant communities were studied with the morphological-ecological-geographical method. The results attest significant differences in their taxonomic and typological structures. In most familial spectra of studied floras, representatives of *Asteraceae* and *Poaceae* families prevail, while the counts of species of families *Brassicaceae*, *Caryophillaceae*, *Fabaceae* and *Lamiaceae* are also high, In the alien fraction of the studied flora, the importance of the following families increases: *Amaranthaceae*, *Apiaceae*, *Asteraceae*, *Brassicaceae*, *Euphorbiaceae*, *Lamiaceae*, *Malvaceae*, *Portulacaceae*. Most weeds pertain to annual xeromesophilic species. The work is aimed at formation and development of sustainable agro-environmental systems with rational use of biological resources.

## 1. Introduction

Influence of technogenic factors causes significant geo-environmental problems in habitat of humans, organisms and plants [1–3]. In various regional territories, anthropogenic impact is made by genetic transformations of phytobiota and is a defining factor in formation of vegetation cover [4–6]. Studies of plant communities is theoretically and practically important, as weeds and alien species which are their main components have a significant influence over formation, development and yield of agricultural crops. Under such conditions, a large number of introduced and alien species [7, 8] appear. Global losses of crop harvest due to weeds and other plant pests are 500-510 million tons in grain, 65-75 million tons in sugar beet, 125-135 million tons in potatoes, 78-79 million tons in vegetables, that is 30-40% of the total harvest.

Besides, quarantine pests may actively spread through crop plantings, determining a necessity for regular monitoring of fields [9]. Specifics of growth practices of different crops may significantly differ, as well as conditions under which the vegetation cover is formed in the crop plantings. Thus, plant communities differ considerably from each other. At the same time, the peculiarities of weed flora formation are currently understudied. That is why, from the fundamental science point of view it it necessary to identify regularities in formation of field weed flora depending on environmental and

floristic factors, as well as influence from cultivation of specific crops. The type of biological resources is defined by changes in the natural environmental and socio-economical features of specific territories [10]. Research presented in this work will allow creating an algorithm for agro-environmental functioning of sustainable agro-environmental systems and a model of their development, as well as developing scenarios of agro-environmental system formation and different variants of biological resource use.

The purpose of the study was in identifying the formation-related features of plant communities in plantings of various crop in the south-west of the Central Russian Upland, which is considered here within the administrative boundaries of Belgorod oblast, Russia.

The following tasks were involved in attaining the set goal:

- to identify species composition of field weed flora in plantings of various crops;
- to determine the ration of aboriginal and alien species in a plant communities being studied;
- to analyze taxonomical structure of plant communities that is formed within the areas taken by different crops.

## 2. Materials and methods

The subject of research was represented by various floral complexes formed in plantings of the following crops: *Beta vulgaris* L., *Echinaceae purpurea* (L.) Moench, *Fagopirum esculentum* Moench, *Glycine max* (L.) Merr., *Helianthus annuus* L., *H. tuberosus* L., *Medicago sativa* L., *Onobrychis viciifolia* Scop., *Pisum sativum* L., *Trifolium sativum* L., *Triticum aestivum* L., *Zea mays* L. Besides, floral complexes were obtained from fallow lands free from crops.

Field studies employed the methods of reconnaissance floristic survey with field documenting, herborization and subsequent critical-systematic in-office processing of collected material. The morphological-ecological-geographical method was applied to studying species diversity of the floral complexes and plant communities. The scientific-theoretical foundation of the critical analysis of species composition was formed by a monotypical concept of species as geographic variety. This approach allows for more precise reflection of limited regional or local flora.

## 3. Results and Discussion

As a result of field surveys conducted in plantings of various crops in the south-west of the Central Russian Upland, new locations of plants previously unaccounted in the region were registered: *Consolida orientalis* (J. Gay) Schröd., *Ptelea trifoliata* L., *Inula ensifolia* L., *Astragalus dasyanthus* Pall., *Amaranthus graecizans* L., *Neslia paniculata* (L.) Desv., *Eriochloa villosa* (Thunb.) Knuth.

**Table 1.** Number of species in plantings of different crops

| Average number of species (from – to) | Crop |
|---|---|
| 0-10 | *Fagopyrum esculentum* – 10 |
| | *Pisum sativum* – 7 |
| | *Trifolium satvum* – 7 |
| 10-20 | *Onobrychis viciifolia* – 19 |
| | *Helianthus tuberosus* – 16 |
| | *Medicago sativa* – 16 |
| | *Beta vulgaris* – 15 |
| 20-30 | *Glycine max* – 27 |
| | *Zea mays* – 27 |
| | *Triticum aestivum* – 26 |
| | *Echinaceae purpurea* – 22 |
| <30 | *Helianthus annuus* – 37 |

**Table 2** Familial spectrum plant communities formed in plantings of various crops

| Number / Family | Asteraceae | Poaceae | Brassicaceae | Caryophyllaceae | Chenopodiaceae | Fabaceae | Boraginaceae | Lamiaceae | Amaranthaceae | Ranunculaceae | Euphorbiaceae | Plantaginaceae | Polygonaceae | Rubiaceae | Rosaceae | Aceraceae | Apiaceae | Primulaceae | Cyperaceae |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wheat | | | | | | | | | | | | | | | | | | | |
| Species | 26 | 13 | 4 | 4 | 3 | 2 | 3 | 6 | 3 | 2 | 2 | 2 | 5 | 0 | 5 | 1 | 2 | 1 | 0 |
| Percentage | 26.8 | 13.4 | 4.1 | 4.1 | 3.1 | 2.1 | 3.1 | 6.2 | 3.1 | 2.1 | 2.1 | 2.1 | 5.1 | 0 | 5.2. | 1.0 | 2.1 | 1.0 | 0 |
| Maize | | | | | | | | | | | | | | | | | | | |
| Species | 27 | 17 | 6 | 2 | 2 | 6 | 3 | 2 | 2 | 4 | 3 | 4 | 4 | 1 | 1 | 1 | 2 | 2 | 0 |
| Percentage | 26.7 | 16.8 | 5.9 | 2.0 | 2.0 | 5.9 | 3.0 | 2.0 | 2.0 | 4.0 | 3.0 | 4.0 | 4.0 | 1.0 | 1.0 | 1.0 | 2.0 | 2.0 | 0 |
| Beet | | | | | | | | | | | | | | | | | | | |
| Species | 15 | 6 | 2 | 0 | 1 | 2 | 1 | 1 | 1 | 1 | 3 | 1 | 4 | 1 | 3 | 0 | 0 | 0 | 0 |
| Percentage | 30.6 | 12.2 | 4.1 | 0 | 2.0 | 4.1 | 2.0 | 2.0 | 2.0 | 2.0 | 6.1 | 2.0 | 8.2 | 2.0 | 6.1 | 0 | 0 | 0 | 0 |
| Sunflower | | | | | | | | | | | | | | | | | | | |
| Species | 37 | 15 | 7 | 2 | 4 | 18 | 3 | 5 | 2 | 1 | 2 | 3 | 3 | 3 | 3 | 1 | 2 | 1 | 1 |
| Percentage | 27.8 | 11.3 | 5.3 | 1.5 | 3.0 | 13.5 | 2.3 | 3.8 | 1.5 | 0.8 | 1.5 | 2.3 | 2.3 | 2.3 | 2.3 | 0.8 | 1.5 | 0.8 | 0.8 |
| Clover | | | | | | | | | | | | | | | | | | | |
| Species | 7 | 1 | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Percentage | 38.9 | 5.6 | 5.6 | 0 | 11.1 | 5.6 | 5.6 | 0 | 0 | 5.6 | 0 | 11.1 | 5.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Coneflower | | | | | | | | | | | | | | | | | | | |
| Species | 22 | 5 | 1 | 0 | 3 | 4 | 1 | 4 | 1 | 0 | 2 | 2 | 1 | 0 | 2 | 0 | 1 | 0 | 0 |
| Percentage | 43.1 | 9.8 | 2.0 | 0 | 5.9 | 7.8 | 2.0 | 7.8 | 2.0 | 0 | 4.0 | 4.0 | 2.0 | 0 | 4.0 | 0 | 2.0 | 0 | 0 |
| Fallow lands | | | | | | | | | | | | | | | | | | | |
| Species | 37 | 15 | 5 | 2 | 5 | 9 | 7 | 4 | 1 | 2 | 1 | 3 | 2 | 0 | 3 | 2 | 3 | 1 | 0 |
| Percentage | 30.6 | 12.4 | 4.1 | 1.7 | 4.1 | 7.4 | 5.8 | 3.3 | 0.8 | 1.7 | 0.8 | 2.5 | 1.7 | 0 | 2.5 | 1.7 | 2.5 | 0.8 | 0 |
| Sainfoin | | | | | | | | | | | | | | | | | | | |
| Species | 19 | 8 | 1 | 1 | 1 | 4 | 1 | 6 | 0 | 1 | 1 | 2 | 1 | 0 | 2 | 0 | 1 | 0 | 0 |
| Percentage | 34.5 | 14.5 | 1.2 | 1.8 | 1.8 | 7.3 | 1.8 | 11.0 | 0 | 1.8 | 1.8 | 3.6 | 1.8 | 0 | 3.6 | 0 | 1.8 | 0 | 0 |
| Girasole topinambur | | | | | | | | | | | | | | | | | | | |
| Species | 16 | 6 | 5 | 1 | 3 | 4 | 3 | 6 | 1 | 1 | 1 | 1 | 0 | 0 | 2 | 1 | 2 | 0 | 0 |
| Percentage | 27.6 | 10.3 | 8.6 | 1.7 | 5.2. | 6.9 | 5.2. | 10.3 | 1.7 | 1.7 | 1.7 | 1.7 | 0 | 0 | 3.4 | 1.7 | 3.4 | 0 | 0 |
| Soy | | | | | | | | | | | | | | | | | | | |
| Species | 27 | 16 | 6 | 4 | 4 | 9 | 4 | 4 | 2 | 1 | 2 | 2 | 3 | 1 | 6 | 1 | 3 | 0 | 0 |
| Percentage | 24.1 | 14.3 | 5.4 | 3.6 | 3.6 | 8.0 | 3.6 | 3.6 | 1.8 | 0.9 | 1.8 | 1.8 | 2.7 | 0.9 | 5.34 | 0.9 | 2.7 | 0 | 0 |
| Pea. | | | | | | | | | | | | | | | | | | | |
| Species | 7 | 2 | 0 | 4 | 2 | 1 | 0 | 2 | 1 | 0 | 0 | 2 | 4 | 0 | 0 | 0 | 1 | 0 | 0 |
| Percentage | 21.9 | 6.25 | 0 | 12.5 | 6.3 | 3.1 | 0 | 6.2 | 3.1 | 0 | 0 | 6.3 | 12.5 | 0 | 0 | 0 | 3.1 | 0 | 0 |
| Buckwheat | | | | | | | | | | | | | | | | | | | |
| Species | 10 | 3 | 2 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 2 | 1 | 2 | 0 | 3 | 0 | 2 | 1 | 0 |
| Percentage | 27.0 | 8.2 | 5.4 | 5.4 | 2.7 | 5.4 | 2.7 | 2.7 | 0 | 0 | 5.4 | 2.7 | 5.4 | 0 | 8.1 | 0 | 5.4 | 2.7 | 0 |
| Alfalfa | | | | | | | | | | | | | | | | | | | |
| Species | 16 | 6 | 3 | 4 | 2 | 5 | 1 | 3 | 1 | 2 | 1 | 1 | 3 | 0 | 1 | 1 | 1 | 1 | 1 |
| Percentage | 27.6 | 10.3 | 5.2. | 6.9 | 3.4 | 8.6 | 1.7 | 5.2. | 1.7 | 3.4 | 1.7 | 1.7 | 5.2. | 0 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |

Among the studied plots, the highest average number of species was registered in fallows and in plantings of sunflower *Helianthus annuus* (37 species); somewhat fewer species were registered in fields occupied with *Glycine max* and *Zea mays (*27) (Table 1). The group of crops with high average number of species (from 20 to 30 species) also includes *Triticum aestivum* (26) and *Echinaceae purpurea* (22). The group with the moderate number of plant species (from 10 to 20 species) included fields used to grow *Onobrychis viciifolia* (19 species), *Helianthus tuberosus* and *Medicago sativa* (16 species each),

*Beta vulgaris* (15). Plantings of the following crops included the smallest number of species: *Fagopyrum esculentum* (10 species), *Pisum sativum* (7), *Trifolium satvum* (7).

Taxonomic analysis of flora found in plantings of various crops allowed the authors revealing a number of regularities in their formation (Table 2). In most familial spectra of studied floras, representatives of Asteraceae and Poaceae families prevail, while the counts of species of families Brassicaceae, Caryophillaceae, Fabaceae and Lamiaceae are also high, which is typical of not only regional, but holarctic flora in general. At the same time, the role of families Apiaceae, Cyperaceae, Euphorbiaceae is reduced, while their place in the regional flora is traditionally high. Spectra from plantings of *Triticum aestivum*, *Helianthus annuus* and *Glycine max* show most similarity to the regional spectra and are more even in the number of species; this fact seems to be related to these crops being grown in highly diverse locations within the region. High biodiversity and similarity of the familial spectrum to the regional one is typical of fallow lands.

There, just like in plantings of *Trifolium sativum*, we may find a significant number of members of the *Chenopodiaceae* family. It is related to seral processes that take place within the boundaries of fallows. The authors noted a number of spectra non-typical of the region, significantly different in species composition in a number of families in comparison with most of other crops. They include, plantings of sunflower, where following Asteraceae (37 species), the second position is taken by the Fabaceae family (18 species, 13.5%). Members of the Rosaceae family take positions higher than in the regional spectrum in plantings of *Glycine max* and *Triticum aestivum,* which seems to be related to presence of escaped members of this family in forest shelter belts. Specificity of familial spectrum of flora formed in plantings of *Pisum sativum* is in the high ranks of Chenopodiaceae and Polygonaceae families.

The results of our research attest that the share of alien species in plantings of different crops differs as well. The highest number of species has been registered in fallows, followed by a group that includes the following crops: *Helianthus annuus*, *Triticum aestivum*, *Glicine max* and *Zea mays*. However, presence of alien species does not differ drastically between plantings. Most plants found in this group may be also found growing in plantings of *Helianthus annuus*, *Triticum aestivum*, *Glicine max*, while they are least common among *Trifolium sativum* (Figure 1).

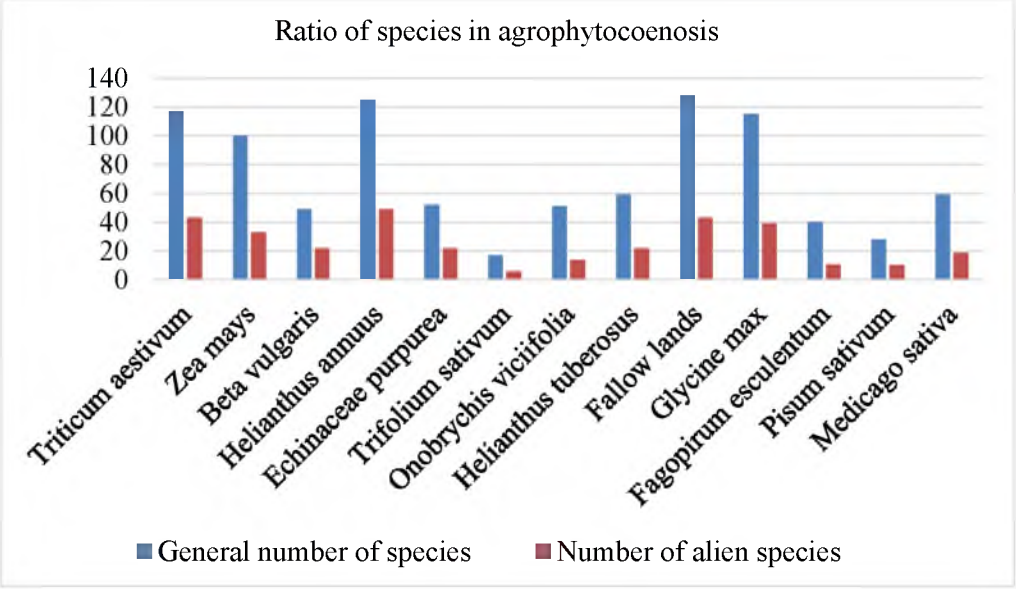


**Figure 1.** Ratios between the total number of species and the number of alien species in plantings of crops.

During the reconnaissance floristic survey of the experimental plot, 21 plant species have been identified in the studied plant communities. The following species of weeds were found dominating in

conditions of different agricultural fields: *Setaria pumila* (Poir.) Schult., *Thlaspi arvense* L., *Amaranthus retroflexus* L., co-dominated 8 species: *Galium aparine* L., *Polygonum aviculare* L., *Chenopodium album* L., *Sonchus arvensis* L., *Capsella bursa-pastoris* (L.) Medik. *Convolvus arvensis* L. etc. *Erodium cicutarium* (L.) L'Her were growing individually.

Analysis of plant communities attests that their structures show a trend for increased number of species of Mediterranean, American, Asian and Iran-Turanic origin. In the alien fraction of the studied flora, the importance of the following families increases: *Amaranthaceae*, Apiaceae, Asteraceae, Brassicaceae, Euphorbiaceae, Lamiaceae, Malvaceae, Portulacaceae. Most weeds pertain to annual xeromesophilic species.

## 4. Conclusion

The studies of plant communities in the south-western part of the Central Russian Upland that are formed in plantings of *Beta vulgaris*, *Echinaceae purpurea*, *Fagopyrum esculentum*, *Glycine max*, *Helianthus annus*, *H. tuberosus*, *Medicago sativa, Onobrychis viciifolia*, *Pisum sativum*, *Trifolium satvum, Triticum aestivum*, *Zea mays* revealed the species composition of the communities. It has been established, that in most familial spectra of studied floras, representatives of Asteraceae and Poaceae families prevail, while the species counts of families Brassicaceae, Caryophillaceae, Fabaceae and Lamiaceae are also high, which is typical of not only regional, but holarctic flora in general. At the same time, studies of plant communities in the south-western part of the Central Russian Upland attest to significant differences in their taxonomical and typological structures.

The highest number of species has been registered in fallows, followed by a group that includes the following crops: *Helianthus annuus*, *Triticum aestivum*, *Glicine max* and *Zea mays*. However, presence of alien species does not differ drastically between plantings.

There is a trend for increased number of species of Mediterranean, American, Asian and Iran-Turanic origin. In the alien fraction of the studied plant communities that appeared as a result of human activities, the importance of the following families increases: *Amaranthaceae*, Apiaceae, Asteraceae, Brassicaceae, Euphorbiaceae, Lamiaceae, Malvaceae, Portulacaceae. Most weeds pertain to annual xeromesophilic species.

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