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WEEDS MAPPING FROM WHEAT CROPS

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Abstract

The study of weed flora dynamics in agricultural crops is a complex and never-ending process which requires the continuous inventory and monitoring of problem weeds that cause the greatest damages on crops, according to which the most effective fighting strategies are established. The mapping action was carried out in fields cultivated with winter wheat in crop rotation and in monoculture crop from Ilfov, Giurgiu and Constanta counties. Weed files have been drawn up for each fields and they have shown the density, participation and constancy of each weed species. The analysis of the data shows that the dominant species in the fields where the wheat was cultivated in crop rotation system were: Veronica hederifolia, Veronica persica and Setaria pumila in Giurgiu county, V. hederifolia and V. persica in Ilfov county, V. hederifolia and Polygonum convolvulus in Constanta county. In monoculture system the number of weeds was higher and several species appeared, including weeds on the list of invasive species: Ambrosia artemisifolia and Coniza Canadensis. Regarding the distribution of weed species by botanical groups, the largest group was the one of the annual dicotyledonous and among the perennial dicotyledonous the most important species were Cirsium arvense and Convolvulus arvensis. From the group of annual monocotyledonous, the most important species were those of the genre Setaria and broad-leaved cockspur (Echinochloa crus-galli), species that invades all cultures in our country and is found in all areas and is also considered to be an invasive species. The dominant species in both crop rotation and monoculture system belong to the Veronica genre, exceeding an average density of 100 plants/m².

Key words*: dominant species, invasive species, mapping, weeds.*

INTRODUCTION

Damages caused by weeds to agricultural crops are diverse, large and irrecoverable by quantitative and qualitative reduction of the crop yields, disturbing maintenance works, increasing the cost price, toxic effects for humans and animals, favoring and transmitting insect pests and disease pathogens and extra costs due to the spreading of weeds as well, especially the invasive ones.(Sarpe et al., 1976; Chirila, 2001; Berca, 1996, 2004). Weeds infestation of agricultural crops is a dynamic process and represents the qualitative and quantitative expression of the influence of the soil seeds stock, the changes in plant cultivation technology and the weed control management. Changes in the dynamic of segetal flora are more evident if they are studied for a long time and on large agricultural surfaces, as they allow conclusions to be drawn regarding the occurrence of new weed species, the increasing importance of some of the existing ones, or the reduction in importance of others, or the disappearance of certain species from agricultural crops (Berca, 2004). Many studies, observations and conclusions were presented by many researchers (Sarpe et al., 1976; Berca, 1996, 2004; Budoi, Penescu, 1996; Ellenberg, 1998; Hanegraaf et al., 1998; Chirila, 2001; Lososova et al., 2004) showing that, as a general rule, the number of weed species decreases, so as the number of weeds/m², but that new species appear or the importance of the already existing ones changes by time. There have been concerns about the dynamics of segetal florain Romania, from the first synthesis information (Prodan, 1939) to the present, but especially between 1973-2000 when a nationwide study known as "weed mapping" was developed in order to establish the structure and the degree of qualitative and quantitative weed infestation at the level of common areas, villages, farms, plots and crops as well as to determine the changes in the segetal flora dynamics. Weed mapping is a necessary measure to determine the degree of infestation and the prognosis of weed emergence in all agricultural crops, and allows differential weed control proceedings to

be applied in each plot, avoiding unnecessary application of the herbicides and to elaborate short and medium forecasts of the evolution of weed infestation. As a result, the paper presents the data obtained by mapping the wheat crop weeds in 3 counties from southeastern Romania.

MATERIALS AND METHODS

Weed mapping was conducted in 10 fields cultivated with winter wheat included in a suitable crop rotation and in 10 winter wheat cultivated fields in monoculture from the counties of Ilfov, Giurgiu and Constanta during the period 2015-2017.The numerical method of weeds assessments was used to which the phenophase and the average height of each plant were added. There were 8 samples made for each 1 hectare surface.

The winter wheat field in which the assessments were made were cultivated by private farmers according to their own technologies. For each field, landfills of weed infestation have been done and they present both general data on the location, the soil type, the previous crop and specific data on the density, participation and constancy of each weed species, class (monocotyledonous or dicotyledonous) as well the life period of each weed (ephemeral, annual, biennial, or perennial). For sampling and weeds inventory, the metric frame (1 m^2) was used. Each sampling point was established by going through the field in 1-2 diagonals according to the number of specified samples. At the final stage, the data obtained from all the analysed samples from one year, as well as from the three years in which determinations were made, were centralized. The data obtained on weed infestation of winter wheat crop cultivated in rotation crop system and in monoculture reveals the ecological characteristics of the weed flora existing at a certain moment in the studied fields. Finally, the weeds were distributed in density categories in descending order to identify the dominant species and the problem weeds, the results obtained by mapping being an important tool in taking the most appropriate weed control measures in a crop.

RESULTS AND DISCUSSIONS

Winter wheat crops in Romania are yearly weed-infested, especially in monoculture, with segetal species belonging to diverse, annual, biennial and perennial botanical families, some of them very difficult to fight against. Thus, in wheat monoculture crop from Constanta county 32 weed species with an average density of 263.4 plants/m^2 were identified (Table 1). Among the weeds found in a crop, we were concerned about only 5-10 species because they excel by the large number of individuals. These species are usually dominant and are important because they cause important losses on crops. From a practical point of view, these species have been called problem-weeds. These, due to their specific biology (Sagar, Hawson, 1994), by their density (Spitters, 1983; Wilson, Wright, 1990) and relative resistance to control measures, concern the farmers about the damages they can produce. Among the problem weeds, some are considered target species, according to which specific weed control decisions are taken in a crop. (Ionescu et al., 2016). In order to identify the problem weeds and establish the target species, the studied weeds were divided into 4 density categories. The first category, the most dense with 20-40 plants/m^2, included the species: *Veronica hederifolia* L., *Polygonum convolvulus* L., *Chenopodium album* L. and *Echinochloa crus-galli* (L.) Pal. Beauv. The second category had a density of 10-20 plants/m^2, being found the following species: *Convolvulus arvensis* L., *Cirsium arvense* (L.) Scop., *Solanum nigrum* L. and *Veronica persica* Poir. From the third group, with 5-10 plants/m^2, there were identified: *Sinapis arvensis* L., *Apera spica-venti* (L.) Pal. Beauv., *Setaria viridis* (L.) Pal. Beauv., *Matricaria inodora* L. and *Papaver rhoeas* L. The fourth group with 1-5 plants/m^2 was the largest, including 20 species, the most important being as follows: *Capsella bursa-pastoris* (L.) Medic., *Taraxacum officinale* Weber., *Lamium amplexicaule* L., *Cardaria draba* (L.) Desv., *Ambrosia artemisiifolia* L. etc.

Table 1. Weeds in wheat monoculture, Constanta county

Wheat Monoculture (2 years)			
Species	Growth stage/height (cm)	Ave-rage no./m^2	K (%)
Veronica hederifolia	A-B-C 6-10	40.5	100.0
Polygonum convolvulus	A 25-30	35.0	100.0
Chenopodium album	A 10-25	25.5	87.5
Echinochloa crus-galli	A 3-15-20	22.5	87.5
Cirsium arvense	A 12	12.5	62.5
Solanum nigrum	A 15-20	12.0	50.0
Veronica persica (I)	A-B-C 10-12	10.5	87.5
Convolvulus arvensis	A-B 25	10.2	50.0
Sinapis arvensis	A15	8.6	37.5
Apera spica-venti	A 15	8.5	37.5
Setaria viridis	A 8-20	8.4	50.0
Papaver rhoeas	A 10-25	8.0	37.5
Matricaria inodora	A-C 20-25	6.0	37.5
Pplygonum aviculare	A 10-15	5.0	25.0
Capsella bursa-pastoris	A 10	4.5	25.0
Taraxacum officinale	A-C 10-15	4.4	12.5
Lamium amplexicaule	A-B-C10-14	4.2	25.0
Cardaria draba	A 20	4.0	25.0
Ambrosia artemisiifolia (I)	A 10-15	3.5	12.5
Thlaspi arvense	A 25-30	3.5	12.5
Galeopsis tetrahit	A 10	3.2	12.5
Descurainia sophia	A 12-15	3.2	12.5
Anagalis arvensis	A 10	3.0	12.5
Bromus secalinus (I)	A 20-25	2.4	25.0
Raphanus raphanistrum	A 15-20-30	2.2	12.5
Sonchus arvensis	A 25	2.2	12.5
Stachys annua	A 12-15	2.0	12.5
Veronica arvensis	A10	2.0	25.0
Viola arvensis	A-B-C 6-10	2.0	12.5
Agroryuron repens	A 20-30-50	1.0	12.5
Sonchus oleraceus	A10-18	1.0	12.5
Cirsium vulgare	A15-20	1.0	12.5
Conyza Canadensis (I)	A20-40	1.0	12.5
TOTAL		**263.4**	

Legend
A-5-7 leaves unfolded/shoot; B-flower buds/ Gramineous-bootstage; C-Flowering
P% = Proportion in which each species was involved to general weed infestation
K% = Proportion in which each species was found in observation points
MP = perennial monocotyledonous; MA = annual monocotyledonous
DP = perennial dicotyledonous; DA = annual dicotyledonous; I = invasive species

Generally, the species that infest the wheat crops are part of the group of weeds that grow in the spring and systematically they are usually annual and perennial dicots (Anghel et al., 1972; Mortimer, 1996; Slonovoski et al., 2001). Regarding the distribution of weed species on botanical groups, in wheat monoculture from Constanta county predominated the annual dicots with 19 species (Table 2), which had an average density of 182.9 plants/m^2 and a rate of 69.3% in the general weed infestation process. When the wheat was included in an appropriate crop rotation, having had the winter oil rape as previous crop, only 14 species of weeds with an average density of 116 plants/m^2 were determined in Constanta County, of which 10 annual species are dicotyledonous, 1 perennial dicotyledonous species and 2 species of the annual monocotyledonous class (Figure 1 and Figure 2).

Table 2. Weeds in wheat rotation, Constanta county

Wheat Rotation (previous crop: winter oilseed rape)			
Species	Growth stage/ Height (cm)	Average no/m^2	K %
Veronica hederifolia	A- B-C 6-8	30.0	100.0
Polygonum convolvulus	A 15-20	24.0	87.5
Chenopodium album	A 15	14.0	62.5
Solanum nigrum	A 15	10.5	50.0
Echinochloa crus-galli	A 8-10	10.0	50.0
Veronica persica (I)	A- B-C 6-8	8.0	75.0
Sinapis arvensis	A 15	5.0	50.0
Cirsium arvense	A 10-15	5.0	37.5
Papaver roheas	A 12-15	2.5	25.0
Fumaria schleicheri	A 13	2.5	12.5
Setaria viridis	A12	1.5	12.5
Matricaria inodora	A-B 18-30	1.0	12.5
Hibiscus trionum	A15	1.0	12.5
Ranunculus sardous	A16	1,0	12.5
TOTAL		**116**	

In the wheat monoculture crop in Constanta county (Table 1), there were also identified four invasive species compared to wheat in crop rotation system where only one species was identified (*V. persica*) (Table 2).

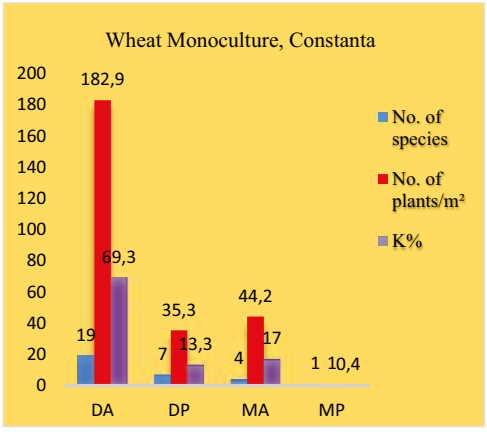

Figure1. Weeds distribution by botanical group in monoculture, Constanta

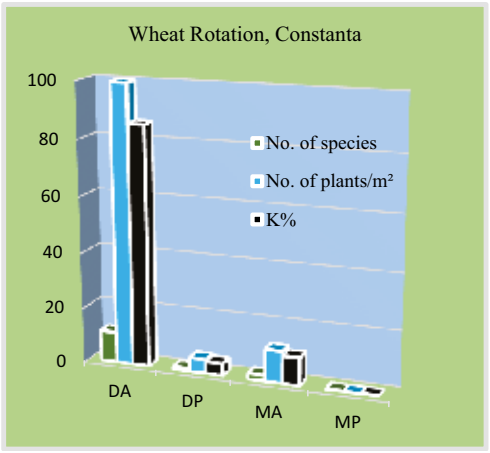

Figure 2. Weeds distribution by botanical group in crop rotation system, Constanta

In Ilfov County, due to the monoculture during 3 years, the degree of weed-infestation exceeded 304.6 plants/m^2 (Table 3), compared to the wheat included in rotation system, having corn as previous crop, at which the degree of weed-infestation was 116.4 plants/m^2 (Table 4).

Table 3. Weeds in wheat monoculture, Ilfov county

Wheat Monoculture (3 Years)			
Species	Growth stage Height (cm)	Average no./m^2	K %
Veronica hederifolia	A- B-C 5-8-18	48.0	100.0
Veronica persica (I)	A- B-C 6-16	37.0	100.0
Galium aparine	A 10-20	31.0	87.5
Convolvulus arvensis	A-B 15-20	28.5	75.0
Polygonum convolvulus	A 20-30	22.0	62.5
Cirsium arvense	A 10-20	20.4	50.0
Echinochloa crus-galli	A 5-10-20	20.0	75.0
Veronica arvensis	A-B-C 5-12	16.5	62.5
Matricaria inodora	A-B 12-20	12.0	37.5
Sttelaria media	A 15	10.0	25.0
Lamium amplexicaule	A-C 8-14	10.0	25.0
Chenopodium album	A 3-20	8.5	25.0
Papaver roheas	A-B 12-40	8.0	12.5
Setaria pumila	A 5-10	7.0	25.0
Capsella bursa-pastoris	A 12-15	6.5	12.5
Setaria viridis	A 3-15	5.2	25.0
Sinapis arvensis	A15	5.0	12.5
Matricaria chamomilla	A-B 12-24	3.5	12.5
Centaurea cyanus	A 30-35	2.5	12.5
Descurainia sophia	A 20	2.0	12.5
Lolium multiflorum (I)	A10-20	1.0	12.5
TOTAL		**304.6**	

Due to the high density of weeds per m^2, they were divided into 5 density categories.
The group with the highest density ranging from 30 to 50 plants/m^2 was dominated by *Veronica* species along with *Galium aparine (*L.), followed by the group of species with a density ranging from 20 to 30 plants/m^2 consisting of: *C. arvense* (L.) Scop., *P. convolvulus* (L.), *C. arvensis* (L.) and *E. crus-galli* (L.) Pal. Beauv.

Table 4. Weeds in wheat rotation, Ilfov county

Wheat Rotation (Previous Crop: Corn)			
Species	Growth stage/ height (cm)	Average no./m^2	K %
Veronica hederifolia	A-B-C 6-8	28.0	100.0
Veronica persica (I)	A-B-C 8-10	20.8	87.5
Galium aparine	A15-20	14.4	50.0
Stellaria media	A20	10.2	25.0
Chenopodium album	A10-15	10.0	37.5
Convolvulus arvensis	A –B 20	8.0	25.0
Matricaria inodora	A-B 10-12	8.0	25.0
Capsela bursa-pastoris	A10	6.0	12.5
Cirsium arvense	A 6	3.0	12.5
Papaver rhoeas	A10-15	3.0	12.5
Lamium amplexicaule	A-B-C10-12	2.0	12.5
Apera spica-venti	A 25-30	2.0	12.5
Poa annua	A 20	1.0	12.5
TOTAL		**116.4**	

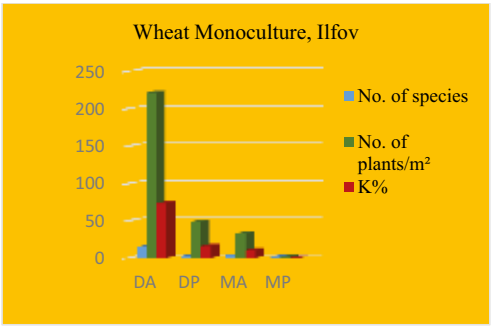

Figure 3. Weeds distribution by botanical group in monoculture, Ilfov

The third group, with 10-20 plants/m^2, included the following species: *Veronica arvensis* (L.), *M. inodora* (L.), *Stellaria media* (L.) Vill. and *L. amplexicaule* (L). The fourth group with 5-10 plants/m^2, had as more important species: *C. album* (L.), *P. rhoeas* (L.), *Setaria* species, *C. bursa-pastoris* (L.) *and S. arvensis* (L.). The fifth group with densities ranging from 1.0-5.0 plants/m^2, included only 4 species with a low density that do not raise any particular problems in weed control.

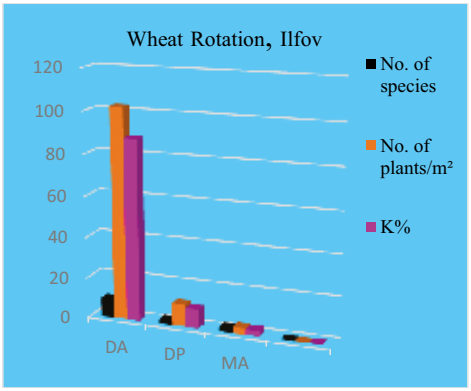

Figure 4. Weeds distribution by botanical group in crop rotation system, Ilfov

In the Ilfov county, in wheat rotation only 13 weed species with an average density of 116.4 plants/m^2 were recorded, of which 9 annual species were dicotyledonous, 2 perennial dicotyledonous species, 2 annual species monocotyledonous species and one was invasive species (Table 3 and Figure 4).

In wheat monoculture crop in Giurgiu county 34 weed species were identified, with an average density of 259.2 plants/m² (Table 6). These species were divided into four categories of density and data analysis showed that in both monoculture and crop rotation system, *Veronica* species prevailed over 40 plants/m^2, being accompanied by the perennial species *C. arvensis* (L.). In Giurgiu county, 2 invasive species *V. persica* Poir. and *Xanthium italicum* Moretti were identified in wheat monoculture, and only one species (*V. persica.)* was identified in the crop rotation system.

The analysis of the obtained data shows that the distribution of weed species by botanical groups was specific and demonstrates the high degree of weed-infestation in the wheat crop as well as it establishes the clear way of action to find the strategic solutions for weed control.

The dominant species from the fields where winter wheat was cultivated in crop rotation system were: *Veronica hederifolia* (L.), *Veronica persica* Poir. and *Setaria pumila* (Poir.) Roem.

In Giurgiu county, *V. hederifolia* and *V. persica* Poir. In Ilfov county, *V. hederifolia* (L.) *and Polygonum convolvulus* (L.) in Constanta county.

Table 6. Weeds in wheat monoculture, Giurgiu county

Wheat Rotation (2 Years)			
Species	Growth stage /height (cm)	Average no./m^2	K %
Veronica hederifolia	A-B-C 6-10	40,0	100.0
Veronica persica (I)	A-B-C 7-8-12	20.5	100.0
Convolvulus arvensis	A-B 20-25	20,0	87.5
Polygonum convolvulus	A 5-25	18,0	50.0
Setaria pumila	A 3-5	16,0	75.0
Echinochloa crus-galli	A 4-8	15.0	75.0
Matricaria inodora		10,0	50.0
Chenopodium album	A3	13.5	50.0
Galium aparine	A 10	12,6	50.0
Cirsium arvense	A10	12,0	50.0
Sinapis arvensis	A5-15	8.5	62.5
Papaver rhoeas	A-B-15-20	8.0	37.5
Lamium amplexicaule	A-C 8-12	7.4	25.0
Setaria viridis	A2-6	7.0	37.5
Capsella bursa-pastoris	A14	6.6	37.5
Centaurea cyyanus	A 12	4,5	25.0
Papaver roheas	A 10	4,5	25.0
Anagallis arvensis	A18-22	4,0	25.0
Matricaria chamomilla	A-B-C 16-20	3,5	25.0
Bifora radians	A14	3.2	25.0
Cardaria draba	A16	3.0	25.0
Erodium cicutarium	A22	2.8	12.5
Lithospermum arvense	A20	2.6	12.5
Myosotis arvensis	A6	2.2	12.5
Plantago major	A 20	2.2	12.5
Polygonum persicaria	A16-24	2.0	12.5
Senecio vulgaris	A10	1.8	25.0
Spergula arvensis	A14	1.4	25.0
Viola tricolor	A-B10	1.4	12.5
Amaranthus retroflexus	A 5-10	1.0	12.5
Sonchus arvensis	A 12	1.0	12.5
Helianthus annuus	A 20-25	1.0	12.5
Xanthium italicum (I)	A 20	1.0	12.5
Agropyron repens	A15-25	1.0	12.5
TOTAL		**259.2**	

Table 7. Weeds in wheat rotation, Giurgiu county

Wheat Rotation (previous crop: winter oilseed rape)			
Species	Growth stage/ height (cm)	Average no./m^2	K %
Veronica persica (I)	A-B-C 7-12	24.0	100.0
Veronica hederifolia	A-C 6-10	20.0	87.5
Convolvulus arvensis	A 5	15.5	75.0
Polygonum convolvulus	A 8	12.5	62.5
Galium aparine	A 10	10.0	50.0
Lamium amplexicaule	A-C 8	8.6	37.5
Chenopodium album	A10	8.2	37.5
Setaria pumila	A5	8.0	37.5
Sinapis arvensis	A7	4.5	25.0
Matricaria inodora	A 10	4.0	12.5
Capsella bursa-pastoris	A 12	3.0	12.5
Papaver rhoeas	A-B 16-18	3.0	12.5
Polygonum aviculare	A10	2.0	12.5
Thlaspi arvense	A10	1.5	12.5
Hibiscus trionum	A8-12	1.0	
TOTAL		**125.8**	

Regarding the distribution of weed species on botanical groups (Figure 5), the largest group was the one of the annual dicotyledonous and among the perennial dicotyledonous, the most important species were *Cirsium arvense* (L.*)* Scop. and *Convolvulus arvensis* (L.).

From the annual monocotyledonous group, the most important species were *Setaria* species and *Cockspur grass (Echinochloa crus-galli* (L.) Pal. Beauv.), a species that invades all crops in our country and is found in all areas and is also considered to be an invasive species (Dihoru, 2004).

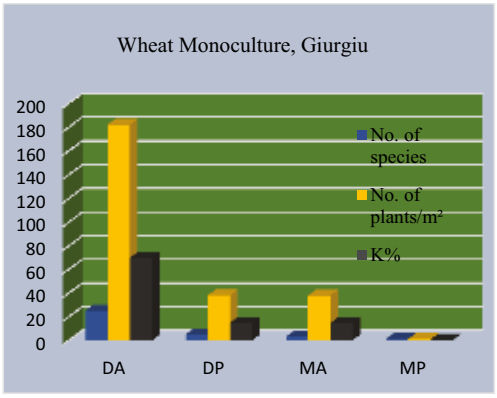

Figure 5. Weeds distribution by botanical group in monoculture, Giurgiu

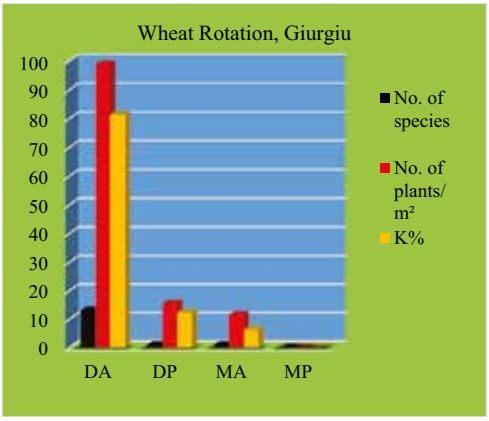

Figure 6. Weeds distribution by botanical group in crop rotation system, Giurgiu

The dominant species in both crop rotation system and monoculture belong to the genus *Veronica*, with 3 species having exceeded an average density of 100 plants/m^2 in the monoculture of winter wheat in Giurgiu county (Table 7).

CONCLUSIONS

Weed mapping is a necessary measure to determine the degree of infestation and the prognosis of weed emergence in agricultural crops.

By centralizing the data according to density and constancy and by separation by botanical groups, the weed control strategy is established.

Wheat crops in Romania are infested every year, especially in monoculture with segetal species belonging to diverse, biennial and perennial botanical families, some of them being difficult to combat. By mapping, there were identified in Constanta county 32 species in wheat monoculture, of which 11 were problem weeds, 8 target species and 4 invasive species: *Veronica persica, Ambrosia artemisiifolia, Bromus secalinus* and *Conyza canadensis.*

In the winter wheat cultivated fields from Constanta county, there were determined 14 species, among 5 of them were problem weeds, 3 target species and 1 invasive species (*Veronica persica*).

In Ilfov county, in monoculture there were identified 21 species - 12 were problem weeds, 7 target species and 2 invasive species: *Veronica persica* and *Lolium multiflorum.*

In the wheat cultivated with wheat in Ilfov county, 13 species were determined, out of which 6 were problem weeds, 4 target species and 1 invasive species (*Veronica persica*).

In wheat crop rotation fields in Ilfov county we found 13 weed species - 6 problem weeds, 4 target species and 1 invasive species. (*Veronica persica*).

In the wheat monoculture in Giurgiu county, 34 species were identified, out of which 13 were problem weeds, 7 target species and 2 invasive species: *Veronica persica* and *Xanthium italicum.*

When the wheat crop was included in a rational crop rotation system in Giurgiu county, 15 species were identified, out of which 5 were problem weeds, 4 target species and 1 invasive species (*Veronica persica*).

The dominant species both in crop rotation system and monoculture belonged to the Veronica species, exceeding an average density of 100 plants/m^2 in wheat monoculture in Ilfov county.

By applying the crop rotation the degree of weed-infestation is significantly reduced compared to monoculture.

The distribution of weed species on botanical groups shows that in addition to the known annual weeds (annual and perennial dicotyledonous), monocotyledonous annuals (*Setaria* and *Echinochloa*), other species of the *Bromus, Avena* and *Lolium* species appear to be more damaging by time.

In order to achieve the control of these weed species in the winter wheat crop, it is recommended to apply 1-2 treatments with herbicides with the widest effectiveness, usually a treatment for dicotyledonous weeds and another separate treatment for monocotyledonous weeds.

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