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DIVERSITY OF WEED SPECIES FROM MAIZE CROP AND IT'S IMPORTANCE FOR NEW ECOLOGICAL WAYS

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ABSTRACT

Being a plant cultivated maize frequently becomes weedy at levels considered dangerously high. The plant, having requirements especially for water, benefits to the greatest extent from the segetal species, namely from the "summer" group. The determinations regarding weed species targeted areas cultivated with maize on private farms. The inventories carried out under these conditions are becoming important today, both for the perspective of weed conservation from an ecological perspective, and as their effective response to the control methods that are taken. The determinations resulted in a total of 22 species. Of these, 13 were part of the annual dicotyledons, 6 were perennial dicotyledons and 2 species were annual monocotyledons. The entire plant spectrum was part of 13 botanical families, the best represented being Poaceae. The species were then grouped according to density and constancy, and under these conditions the dominant species was Echinochloa crus-galli L./P. Beauv. With the help of this data, appropriate decisions can be made to control the entire weed spectrum in maize, especially for the dominant ones. The inventory of weeds in maize thus also acquires a clearly practical character, with the help of which some levels of economic control-fighting intervention are also established.

INTRODUCTION

The entire plant spectrum that forms/appears in maize crops (Hopa 2001, Wanic et al. 2005, Letourneau et al. 2011, Ņečajeva et al. 2015) includes a relatively wide range of botanical species (Werth et al. 2017, Derrouch et al. 2021). These weeds that accompany crop plants, including maize, are also called segetales, or field weeds. The maize growing season usually takes place during the slightly warmer period of the year. From this perspective, weeds that appear in maize-cultivated soils (Doebley 2004) have a specific spring-summer vegetation interval. These species appear, grow and develop only during this interval (Widderick et al. 2010, Travlos e al. 2018). Alongside these, it is possible that representative species from other periods of the year may also appear, alongside which crop plants can join and thus compete (Knezeviç et al. 2002, Gantoli et al. 2013). Research into the full spectrum of plants in agricultural fields, including maize, has demonstrated some important positive influences, such as protecting the agricultural environment (Ramesh 2015), reducing the phenomenon of global warming and even those of obvious CO_2 capture (Petit et al. 2015, Pilipavicius 2015). Currently, the expression of weed species, including in maize crops, demonstrates new valences, such as:

- the phenomenon of the emergence and evolution of weeds is observed (Reimer et al. 2019),
- their influence on climate change and heat stress (Pilipavicius 2015, Werth et all. 2017),
- the influence of these changes on control management (Sanyal et al. 2008, Vasileiadis et al. 2015, Moss 2019, Riemens et al. 2022),
- the place of herbicides for effective control (Janak & Grichar 2016; Dogan et al. 2024),
- the use of new cropping systems, including herbicide-free maize (Ramesh 2015, Soltani et al. 2016, Kudsk & Streibig 2023),
- acceptance of protection degrees of uncultivated areas, with the inventory of weeds,
- application of a new crop system by associating plants (permaculture),
- possible capture of CO_2 concentrations with the help of weed species (Pilipavicius 2015, Derrouch et al. 2021).

Through observations and cyclical determinations of the evolution of the existence of weeds, including in maize, new aspects have been found, demonstrating botanical evolutions, by practicing levels within agricultural systems (Pilipavicius 2015). This evolution has led to the definition of ecotypes of new species, with reference to the respective agricultural areas. Currently, the use of herbicides is considered necessary, given the obvious economic effects (Gharde et al. 2018). Newly emerged ecotypes can adapt through certain reductions in herbicide doses (Petit et al. 2015). One of the new ways to reduce the consumption of chemical substances such as herbicides is to practice different systems of replacement. On this occasion, real challenges have been highlighted, including using the phenomenon of allelopathy. Some of these could be cultural methods and permaculture - with associations between several crop plants. With the presence of the weed vegetation carpet, the harmful periods of climate change have been alleviated (Waniç et al. 2005). Recently, it was being considered that the weed species existing in certain crop fields should be studied and inventoried together with abandoned areas, for weed them ecologically. At the same time, considering global warming, attempts are being made to find answers to mitigate the existence and competition of weeds in agricultural crops.

In the present research, an inventory of all weed species in maize crops was carried out on several soils in Argeș County. With this inventory, the following were determined: the structure of weeds, their division into large botanical classes - annual dicots (AD), perennial dicots (PD), annual monocots (AM) and perennial monocots (PM), membership in botanical families, establishing the density and constancy of each species, as well as establishing the ratio between the number of species, the ratio of the number of weeds per unit area (m^2) and the participation ratio (%). With such research, new directions can be forecasted characterized by a more obvious highlighting of the maize crop ecology.

MATERIALS AND METHODS

The action to map weeds in maize crops was carried out in recent years (2021-2023) in 10 fields cultivated with maize in Argeș County. The respective areas belong to private farmers. Their areas ranged between 1 (one) hectare and 12 hectares. The number of samples (also called surveys) from a field was carried out depending on its size, as follows: 1.5-5.0 ha 10 surveys and over 2.0 ha 20 surveys. Samples analyses were based on specific inventory sheets by registration. The sheets were developed before the field action. The first part of the sheet is general and includes data on the analyzed area, and the second part presents the weed species determined, namely in descending order of their density. For sampling and inventorying weeds in a crop, a metric frame (1 m^2) was used. Each sampling site was established by walking the respective area in 1-2 diagonals (depending on the size of the surface), respecting the number of established samples. The time of inventorying weeds in maize was before the first plowing. In the final phase, the data obtained was centralized, both from all samples analyzed in one year and for the three years. The average weed records in the maize crops are considered to demonstrate at a good level the ecological characteristics offered by the soil type in the region, at the level of technologies used in this period. The two figures show the most widespread species in maize: the bearded grass *Echonochloa crus-galli* (figure 1) and the red grass *Polygonum persicaria* (figure 2). To carry out this inventory of weed species in the maize crop, the following were used: a map on the largest possible scale, a metric frame, an observation notebook and a species determinant. For each soil analysis, the consent of the respective owner was requested.

Figure 1. *Echinochloa crus-galli*/maize

Figure 2. *Polygonum persicaria*/maize

RESULTS AND DISCUSSIONS

The average densities obtained for the weeds determined in each area are presented in the summary table (table 1). It also includes the total number of species determined, the biological category, the average number of weeds per determination, the sum of the species density in the 10 soils analyzed and the areas from which the samples were taken. The table also shows the distribution of weed species in the maize crop. Overall, the general picture obtained demonstrates a relatively high degree of non-uniformity. Next, a distribution of species densities was made on a specific scale. Thus, the average densities obtained were divided into density categories per unit area, namely between 100-350 individuals per m^2, between 50-100/m^2, then those with 10-50/m^2 individuals, 5-10 plants per m^2, and finally those under 5 plants/m^2. Each category was marked with the same color, but at different intensities depending on the density. On this occasion of the inventory of weeds in the maize crop, weed plants observed near the areas at the inventory points were also noted. These were noted as <u>other species</u>, in a separate table (table 2). Some of these have economic importance (those underlined).

Table 1

Weeds species from maize crop of small farms (private ones)

Crt. no.	Species	Biol. Cat.	The mapping areas										
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Sum**
1.	*Echinochloa crus-galli* L./P.B.	AM	**199.5**	**190.2**	**277.5**	**96.0**	**98.3**	**335.6**	**126.4**	**51.6**	**19.7**	**4.8**	**1399.6**
2.	*Digitaria sanguinalis* L./Scop.	AM	**62.8**	**77.3**	**48.0**	**28.5**	**18.7**	**71.6**	**13.2**	**26.0**	**9.9**	**2.7**	**358.7**
3.	*Convolvulus arvensis* L.	PD	**48.5**	**21.3**	**18.5**	**27.0**	**2.8**	**20.8**	**13.6**	**12.8**	**22.9**	**14.4**	**202.6**
4.	*Hibiscus trionum* L.	AD	**41.7**	**89.8**	**1.5**	**4.0**	**9.0**	**27.2**	**10.8**	**22.8**	**3.2**	**2.4**	**212.4**
5	*Polygonum lapathyfolium* L.	AD	**9.3**	**13.8**	**4.0**	**15.0**	**14.2**	**106.8**					**163.1**
6.	*Polygonum persicaria* L.	AD	**3.8**	**3.6**	**1.0**	**1.5**	**1.3**	**8.8**	**2.0**	**1.6**	**3.2**		**26.8**
7.	*Cirsium arvense* L./Scop.	PD	**1.5**	**6.7**	**1.5**	**6.0**		**19.2**	**2.8**	**14.4**	**2.9**	**3.7**	**58.7**
8.	*Linaria vulgaris* Mill.	PD	**1.3**										**1.3**
9.	*Raphanus raphanistrum* L.	AD	**1.0**		**0.5**	**2.5**	**0.5**		**1.2**			**0.5**	**6.2**
10.	*Chenopodium albun* L.	AD	**0.5**	**19.1**	**15.0**	**112.5**	**2.0**		**2.4**	**3.6**	**2.7**		**157.8**
11.	*Plantago major* L.	PD	**0,2**										**0.2**
12.	*Xanthium italicum* Morr.	AD		**12.9**				**2.4**	**0.8**		**2.4**		**18.5**
13.	*Lactuca tatarica* L/Mey.	PD		**3.6**									**3.6**
14.	*Matricaria inodora* L./Sch.-Bip.	AD		**2.7**	**4.0**		**2.0**		**0.4**	**0.4**	**2.4**	**2.4**	**14.3**
15.	*Lactuca serriola* Torn.	AD		**1.3**									**1.3**
16.	*Amaranthus retroflexus* L.	AD		**0.4**	**3.5**		**1.5**	**190,0**			**1.3**		**196.7**
17.	*Cardaria draba* L./Desv.	PD					**24.5**						**24.5**
18.	*Polygonum hydropiper* L.	AD						**6.0**					**6.0**
19.	*Polygonum aviculare* L.	AD										**1.6**	**1.6**
20.	*Stellaria media* L./Viel.	AD							**0.4**			**2.7**	**3.1**
21.	*Portulaca oleracea* L.	AD							**0.8**				**0.8**
22.	*Lolium perenne* L.	PM										**1.3**	**1.3**

	Total no./area	Plt./sq.m	370.1	442.7	375.0	293.0	174.8	788.4	174.8	133.2	70.6	36.5	2859.1
	Surfaces	Ha	1.7	2.3	1.1	1.9	12.2	1.6	1.7	3.0	4.8	3.8	

*AD- annual dicots, PD- perennial dicots, BD- biennual dicots, AM- annual monocots

Density scale No. plants/sq.m	1 - 5	5 -10	10 – 50	50 - 100	100 - 350

Table 2

Another weed species observed from maize crop

Crt. no.	Another weed species	Class
1.	*Bromus arvensis* L.	am*
2.	*Conyza canadensis* L./Cron.	ad
3.	*Elymus repens* L./P.Beauv.	pm
4.	*Euphorbia agraria* M.B.	pd
5.	*Galeopsis speciosa* Mill.	ad
6.	*Stellaria media* L./Viel.	ad
7.	*Gypsophylla muralis* L.	ad
8.	*Hypericum perforatum* L.	pd
9.	*Lactuca serriola* Torn.	ad
10	*Lathyrus tuberosus* L.	pd
11.	*Gypsiphylla muralis* L.	ad
12.	*Ranunculus arvensis* L.	ad
13.	*Vicia cracca* L.	pd
14.	*Crepis setosa* Hall.	ad
15.	*Sinapis arvensis* L.	ad
16.	*Sonchus oleraceus* L./Gou.	ad
17.	*Lolium temulentum* L.	am
18.	*Arctium lappa* L	bd
19.	*Bidens cernua* L.	ad
20.	*Geranium dissectum* Jusl.	ad
21.	*Polygonum convolvulus* L./Dum.	ad
22.	*Portulaca oleracea* L.	ad
23.	*Rumex crispus* L.	pd

*ad- annual dicots, pd- perennial dicots, bd- biennual dicots, am- annual monocots

The importance of these other species complements the determinations made with the metric framework, forming a broader picture of the presence of segetal weeds in the maize crop. Among these species, the presence of perennials is noted. To better observe the diversity of weed species in the maize crop, their separation into large botanical classes was resorted to (table 3). From the data obtained, it is found that the largest number of species belong to annual dicots in number of 13, followed by perennial dicots with 6 species. Annual monocots were present in numbers of two. Perennial monocots of the type of *Lolium perenne* can also be found in the maize crop. Within the three groups, some species are more difficult to control, due to the big competitive power they have, and from an economic point of view require somewhat higher investments. Among the annual monocots, *Echinochloa crus-galli* expresses the greatest competitive power with maize. Among the annual dicotyledons, species from the genre *Amaranthus, Polygonum, Xanthium* and *Chenopodium* have practical importance.

Table 3

Distribution of weed species by botanical classes

No.	Annual monocots	Annual dicots	Perennial dicots	Perennial monocots
1.	*Echinochloa crus-galli*	*Hibiscus trionum*	*Convolvulus arvensis*	*Lolium perenne*
2.	*Digitaria sanguinalis*	*Polygonum lapathifolium*	*Cirsium arvense*	
3.		*Polygonum persicaria*	*Linaria vulgaris*	
4.		*Raphanus raphanistrum*	*Plantago major*	
5.		*Chenopodium album*	*Lactuca tatarica*	
6.		*Xanthium italicum*	*Cardaria draba*	
7.		*Matricaria inodora*		
8.		*Lactuca serriola*		
9.		*Amaranthus retroflexus*		
10		*Polygonum hydropiper*		
11.		*Polygonum aviculare*		
12.		*Stelaria media*		
13.		*Portulaca oleracea*		

Table 4

Weeds structure by botanical family and genus

No.	Bothanical family	Genus
1.	*Amaranthaceae* A.L. Juss	*Amaranthus*
2.	*Malvaceae* A.L. Juss.	*Hibiscus*
3.	*Convolvulaceae* A.L. Juss.	*Convolvulus*
4.	*Scrophulariaceae/Plantaginaceae* Juss	*Linaria*
5.	*Brassicaceae* Burnett	*Cardaria, Raphanus*
6.	*Asteraceae* Dumort./*Compositae*	*Cirsium, Lactuca, Matricaria, Xanthium*
7.	*Caryophyllaceae* A.L. Juss.	*Stellaria*
8.	*Chenopodiaceae* Vent.	*Chenopodium*
9.	*Polygonaceae* A.L. Juss.	*Polygonum*
10.	*Poaceae* Barnhart./*Gramineae*	*Echinochloa, Digitaria, Lolium*
11.	*Portulacaceae* L.	*Portulaca*
12.	*Plantaginaceae* A.L. Juss.	*Plantago*
13.	*Amaranthaceae* A.L. Juss.	*Amaranthus*

To better observe the biodiversity of these segetal species in the maize crop, their membership in the respective botanical families is also presented (table 4). And from this point it is found that they are part of no less than 13 botanical families. The richest families in species were *Asteraceae* with 4 species and *Poaceae* with 3 species. And in the case of botanical families an important diversity is found in the maize crop. From the point of view of their economic control, some of the families require somewhat higher expenses: *Amaranthaceae, Convolvulaceae, Brassicaceae, Chenopodiaceae* and *Polygonaceae*.

The centralization of all data obtained from the inventory action is presented in three directions (table 5). These three directions express the situation obtained in the maize crop a little beat clear and based on them the farmer or any practitioner can develop measures to reduce the influence of maize competition with weeds. He will establish the chemical control strategy through combined herbicides and other measures, for example, weeding, to eliminate competition from each maize-grown area. From the centralized data, it is found that the distribution of weeds is in total 22 species. Their density was 258.91 individuals/m^2. As a participation ratio, annual monocots constituted 61.50 % of the total weed species inventoried.

Table 5

The categories of weed species from maize crop

Species number report		**Weeds/sq.m number report**		**Procentage, % report**	
13- AD	2- AM	80.86- AD	175.83- AM	28.28- AD	61.50- AM
6- PD	1- PM	29.09- PD	0,04- PM	10.17- PD	0,04- PM
Total 22 species		Total number 258.91		Total % 99.99	

Table 6

Distribution of weeds according to the density and constancy (K%)

Echinochloa crus- galli (100), *Polygonum lapathifolium* (60), *Amaranthus retrpflexus* ((50), *Chenopodium album* ((80)
Digitaria sanguinalis (100), *Hibiscus trionum* (100)
Convolvulus arvensis (100), *Cirsium arvense* (90), *Xanthium italicum* (40), *Cardaria draba* (10)
Polygonum persicaria (90), *Polygonum hydropiper* (10)
Raphanus raphanistrum (60), *Plantago major* (10), *Linaria vulgaris* (10), *Matricaria inodora* (70), *Lactuca tatarica* (10), *Lactuca serriola* (10), *Polygonum aviculare* (10), *Stellaria media* (20), *Portulaca* oleracea (10), *Lolium perenne* (10)

Density scale, no.plt/sq.m	0 - 5	5 - 10	10- 50	50 - 100	100 - 200

In addition to establishing the full spectrum of plant biodiversity in the maize crop, two more aspects are necessary: classifying weed species according to density and expressing their presence in a coefficient of constancy in the 10 maize-grown plots analyzed. The data are presented in Table 6.

The species with the highest density and constancy at high values were: *Echinochloa crus-galli, Digitaria sanguinalis, Hbiscus trionum, Convolvulus arvensis*, *Cirsium arvense, Chenopodium album*. The greatest attention should be paid to all these species that have proven to be particularly competitive with maize plants. The weeds in the last category proven to have the lowest densities, as well as their constancy among the maize areas analyzed. These, although they had the lowest spread in the maize crop, could contribute to supporting the competition of the dominant species existing in maize. At the same time, these species also have an important role in terms of supporting biodiversity, soil protection, CO_2 capture and supporting beneficial insects.

CONCLUSIONS

a) The inventory of weed species, including maize, is an important tool in the analysis of weeding in different areas. In principle, the action is carried out with the aim of developing an adequate management strategy. Through such a study, both aspects of biodiversity adapted to a maize plant are brought to attention, but also the invitation for a new perspective of species conservation from a botanical and ecological point of view, both with positive implications for the agricultural environment.

b) In the present research, 10 areas cultivated with maize in the resort area were analyzed. The diversity of the inventoried plants consisted of a few/several of 22 weed species distributed unevenly in the maize crop. The number of plants determined on an area was between 37 and 788 per unit area (m^2). Between the analyzed areas, the average number of weeds of one species was between under 1.0 and 1400 plants/m^2.

c) During the inventory, weed species observed outside the determination points were also noted. A separate table was prepared for these, considering that they make an additional contribution to the biodiversity structure. Their composition was complex.

d) Regarding the botanical classes, the dominant ones were annual dicots - with 13 species, followed by perennial dicots - with 6 species and annual monocots - with 2 (two) species. Among the important species that cause damage to maize, there were two annual monocots (the genera *Echinochloa* and *Digitaria*), 4 of the annual dicots (*Amaranthus, Chenopodium, Polygonum* and *Xanthium*) and two of the perennial dicots (*Cirsium* and *Convolvulus*).

e) The distribution of all weeds belongs to 13 botanical families. The dominant species were the *Asteraceae* family, followed by the *Poaceae* family. The species from the *Amaranthaceae, Chenopodiaceae* and *Polygonaceae* families are also of practical importance.

f) In terms of the control measures to be taken, AD contributed with 13 species whose average density was 80.86 plants/m^2 and AM with 2 species, but whose density was very high, namely at 175.83 plants/m^2.

g) Depending on the densities determined for each species, along with their constancy at the level of the 10 surfaces cultivated with maize, it was found that *Echinochloa* had the highest densities and the highest constancy (K 100 %). Furthermore, species with practical importance were present at the other density levels.

h) Most weeds were located at somewhat lower densities - below 5 % and with a constancy usually between 10-20 %. From this category, only *Matricaria* had a constancy of 70 %. The importance of these species, although it seems to be lower, but if we consider the set of biodiversity obtained, they could contribute to supporting the other species with practical agricultural importance.

i) By inventorying or mapping weed species, a high biodiversity was found in the maize crop. This could have a major impact on the prospects for preserving and even conserving biodiversity, as well as establishing the most appropriate control measures with new, ecological implications.

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