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ALLELOPATHIC EFFECTS OF *CIRSIUMARVENSE* (L.) SCOP. IN HUNGARY

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Abstract

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Among the 76 most dangerous weed species there is the Creeping Thistle, *Cirsiumarvense L. Scop.*, a top ranked weed also in Hungary.*Cirsium arvense* (L.) Scop. Belongs to the order of *Asterales*. This is a very species – rich order common on various habitats, with remarkable ecological plasticity. It is an extremely competitive species, the roots, leaf have allelopathic effects: inhibited germination in wheat and sunflower. *Cirsiumarvense* affects germination of other weeds. We demonstrated that all extracts inhibited test plant germination to certain extent. For test plants winter wheat and maize was used.

Keywords: Cirsiumarvense (L.) *Scop.,*allelopathy, germination inhibition

Introduction

Importance of Cirsiumarvense(L.)Scop.

Among the 76 most dangerous weed species (Hunyadi-Kazinczi, 1991) there is the Creeping Thistle, *Cirsiumarvense L. Scop.*, a top ranked weed also in Hungary (Table 1). In novel weed surveys species exhibiting herbicide-resistance, like *Cirsiumarvense*, occupy a rank in the beginning of the importance order (Pinke, Pál, 2005).

The first national weed survey was performed by Ujvárosi (1973) after the Second World War from 1947 to 1953. The second (1969-71), third (1988-89), fourth (1996-97) were made by the researchers, weed biologists of the Plant and Soil Protecting Stations upon the initializing of the Ministry of Agriculture and Food, later Agriculture and Rural Development. 5th National Weed Survey was practically realised between 2007-2008, similarly to the previous surveys, by the cooperation of the stations' weed specialists and many other botanists and weed community researchers. According to Tóth and Spilák (1998), in the last 50 years there is a certain continuous trend in the Hungarian weed flora. *Cirsiumarvense* (L.)Scop.in the surveys occupied the remarkable 3rd rank, but in the 1969-71 survey reached only a position of 6th and in 1988-89 the 10th. Later, in the 4th National Weed Survey, it came up again to the 7th position, and in the 5th Survey (2007-2008) it reached 3rd rank in autumn cereal crops, 3rd on fallows of autumn cereal crops, 6th on maize fields. On average it was the 4th among the most common weeds (Dancza, 2008) (Table 1).

Underdryclimaticconditions Czimber et. al., (2004) also mention *Cirsiumarvense* amongthefive most commonweed species inintensivewheat and maizefields (Figure 1). Onextensivefields species number and theirtotalcover is higherthanonintensivefields (Figure 2).

Within the cultivated lands, around settlements, there are always uncultivated plots. Ruderal plots exist on soils with ruins and debris, embankments, roads, fallows, compacted edges of arable fields. These plots can be seen as buffer zones, while segetal plant communities, anthropogenic communities and members of the natural vegetation. Effects of agrotechnics can only slightly reach these zones. On ruderal plots agro botany and botany researching the native vegetation meet each other (Szabó, 2006).

Taxonomy and morphology of Cirsiumarvense(L.)Scop.

The species belonging to *Compositae* (Asteraceae) family is polimorphicinitsmorphology (Ujvárosi, 1973) Basedon leaf shape there can be three varieties as differentiated (Table 2):

- *C. a.*var. *arvense*; 1a.*C. a.*var. *integrifolium*
- *C. a.*var. *horridum*
- *C. a.*var. *vestitum* (Solymosi et al., 2005)

Cirsiumarvense (L.) Scop. Belongs to the order of *Asterales*. This is a very species-rich order common on various habitats, with remarkable ecological plasticity (Turcsányi, 1995). The Southern boundary of its US. Habitat lays in Virginia and North California, to the Northit is abundant everywhere in Canada (Hegi, 1909; Korsmo, 1930; Kutschera, 1960; Muenscher, 1960).

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Table 1
Cirsiumarvense(L). Scop. inscope of thefive National WeedSurveys (afterNovák – Dancza – Szentey – Karamán, 2009)

	1947-53	1969-71	1987-88	1996-97	2007-2008						
	OI	C(%)	OI	C (%)	OI	C (%)	OI	C (%)	OI	C (%)	
Autumn wheat	earlysummer	2	1.5150	3	1.1483	10	0.6431	2	1.8400	4	1.5572
	fallow	8	1.8851	9	1.3431	10	0.6472	4	1.8514	4	2.1591
Maize	earlysummer	5	1.4590	7	1.1184	9	0.7120	5	1.4937	6	1.5281
	latesummer	2	2.4911	7	1.1007	10	0.7749	8	1.7740	6	1.9877
Practical importance on arable land	2	2.0031	7	1.1245	8	0.7090	5	1.8070	4	1.7724	

OI= Order of importance C (%)= Coverpercentage

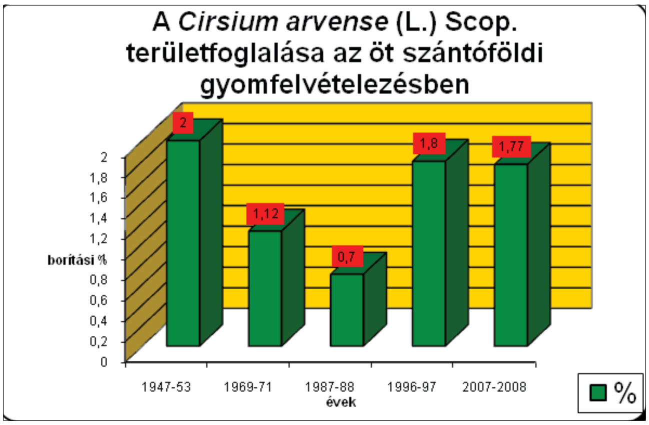

Fig. 1. Coverof C. a. in five arable land weed surveys (after Novák – Dancza – Szentey – Karamán, 2009)

Fig. 2. Plot of Cirsium in wheat field (photo of the authors)

Table 2
Three varieties of Basedon leaf shape

Character	Variety			
	arvense	*horridum*	*integrifolium*	*vestitum*
Stems	Often> 1	Often> 1	Often> 1	Often> 1
Maximum height (cm)	150	150	150	150
Leafundersurface	Green	Green	Occasionally arachnoid-hairy	White or grey tomentose
Leaves	Deeplyobtuselobed	Deeplyacutelobed	Sub-entiretoundulatelobed	Sub-entire toshal-lowundulatelobed
Lamina	Three-dimensional	Three-dimensional	Flat	Flat
Width of undivided area near leaf mid rib (mm)	15	0	35	35
Leaf spines	Stronglyspinose	Lobesstronglyspine-tipped	Marginsweaklyspine-tipped	Marginsweaklyspine-tipped
Capitula	Many	Many	Many	Many
Inflorescence	Branchedopen	Branchedopen	Branchedopen	Branched

Creeping Thistle is a member of *Asteroideae* subfamily. The species-rich genus *Cirsium*is represented in Hungary by the following species: *Cirsium vulgare* (L.) *Scop.* (Creeping Thistle), *C. Furiens Gris. Et Sch*., *C. eriophorum* (L.) *Scop.* (Woolly Thistle), *C. Brachycephalum juratzka*, *C. palustre* (L.) *Scop.* (Marsh Thistle), *C. canum* (L.) *All.* (Queen Anne's Thistle), *C. pannonicum* (L.f.) *Link*, *C. rivulare* (Jacq.) *All.*, *C. oleraceum* (L.) *Scop.* (Cabbage Thistle), *C. erisithales* (Jacq.) *Scop.* (Yellow Melancholy Thistle) (Simon, 2000).

Perennial with G3 life form. Its stem is straight above ground, unbended erected, 0.3-1.5 m tall, hairy and strong lybranching, with dense leaves

Seedproduction (Figure 3) is 5300/plant, onaverage1500/ individual, however, it can be upto 40 000 according to certain literature data, but granivorous insect larvae can reduce it by 60%. According to *Bakker* (1960), seeds can be transported by wind to 20 km. The seed can germinate upon the opening of the shell, Kolk (1947) group it among the species with the shortest lag phase.

This weed can proliferate by seeds or forming clonal colonies from underground stems, thus, combined vitality of generative and vegetative proliferation makes it extremely dangerous. The biggest danger is caused by the root penetrating to a depth of several meters. Several root levels develop; new stems are formed usually from the levels close to the soil surface. 80% of root mass can be found in the upper, tilled 0.3 m layer (Reisinger, 2008).

Its horizontal distribution in soil can reach even 15 m during the vegetation period, during which many colonies are formed (Moore, 1975; Holm et al., 1977). Its root and stem production is measurable during a 4-weeks drought period (Hamdoun, 1972). Even from 50 cm depth a 25mm of underground stem can produce a stem reaching the soil surface (Holm et al., 1977). In arable land perennial weeds can regenerate their pre-tilling equilibrial stage during a short period (1-3 weeks) (Johnson -Buchholtz, 1902; Hunyadi, 1988). From winter additional buds stem formation start sin early summer, and last till late summer continuously (McAllister and Haderlie, 1985) (Figure 4). Swelling of buds on underground stems can start even in January in milder winters (Hamdoun, 1972). Hamdoun (1972) observed, that stems can reach soil surface even from 1.4 m depth.

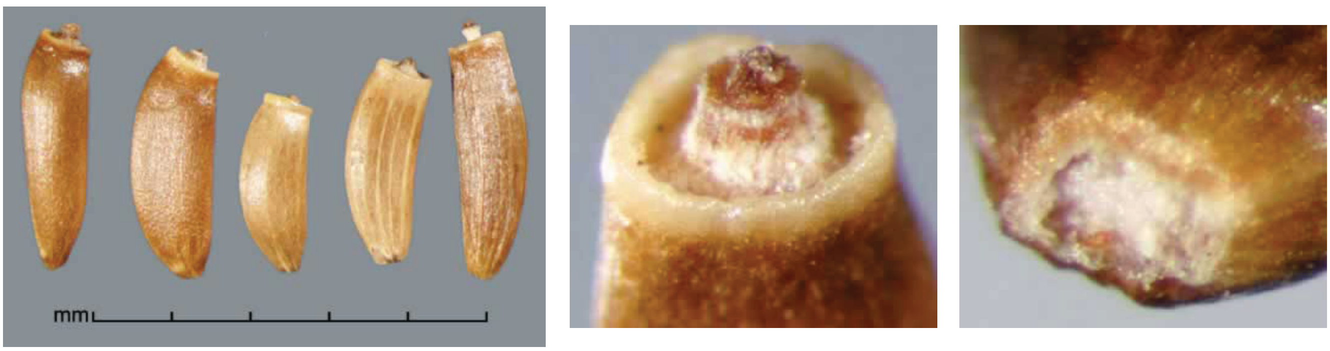

Fig. 3. Crop of Cirsiumarvense (L.) Scop

Fig. 4. Emergence of Cirsiumarvense (L.) Scop.at the first spring survey (photo of the authors)

Ecology of Cirsiumarvense* (L.) *Scop.

The perennial *Cirsiumarvense* (L.) Scop., native to the Eastern Mediterranean and South-East Europe, has been distributed nearly on the whole Earth except the American continent. It occurs in all soil types. It prefers humid, nutrient-rich, dense illuvial loamy soils (Korsmo, 1930; Petersen, 1930; Wehrsag, 1954; Kutschera, 1960; Hanf, 1982). It is not bound to any plant communities. It appears as accompanying species in *Secalineata, Chenopodiete, Artmisietea and Epilobietaliaan gustifolia* phytocoenoses (Oberdorfer, 1957, 1962). It can appear in all arable cultures, and likes ruderal plots as well (Solymosi et al., 2005b).

Characteristics of the habitus, stage, floristic and ecological indicative values, and conservation status are reflected in special index values (Simon, 2000). In the following flora element, life form, TWR indicative values and conservation status of *Cirsiumarvense* is reviewed. The currently used TWR-indicative values of the Hungarian flora (Simon, 2000) are based on the data of Zólyomi and Précsényi (1964), Zólyomi B. et al. (1966), Kárpáti and Kárpáti (1972), Kárpáti (1978), Ellenberg (1950).

Cirsiumarvense (L.) Scop. is an Eurasian-Mediterranean flora element. It is a cryptophyte geophyte according to Raunkier's life form classification, refined by Priszter (1992). The taxa can be classified according to their ecological preference, tolerance (temperature, humidity, soil reaction). The advantages of this system: adequate for the whole Hungarian flora (more than 2500 taxa, which is twice as big as the Ellenberg-system. Furthermore, values for species with wide tolerance range get a medium value of 5, in contrast to Ellenberg where it is marked as x, without a numerical value. The system supports comparisons to the flora of other European countries (not to forget that plant communities do not respect state borders).

Cirsiumarvense, according to its relative heat demand (TB), prefers the mountain deciduous mesophil forest zone, as microclimate (TB5). Its relative soil, water and humidity (WB) category is WB4 – semiarid habitats. By soil reaction (RB) belongs to RB6, plants of neutral soils or of wide range tolerance, indifferent plants. Its relative nitrogen-demand (NB) is NB7, one for nutrient rich environments. Relative light demand (LB) is LB8, direct sunshine plant; photosynthesis is min. 40%, only exceptionally lower. Tolerance of extreme climatic effects (CB): CB5, in the category of transient types, mildly suboceanic and subcontinental. Salt tolerance and salt preference (SB) is SB1: slightly salt tolerant plants that occupy salt deficient or saltless soils, sometimes mildly salty soils (0-0.1% Cl^-).

Allelopathic effects of Cirsiumarvense (L.) Scop. in Hungary

It is an extremely competitive species, the roots, according to Béresand Csorba (1992) have allelopathic effects. Torma et al. (2004) investigated the allelopathic effect of *Cirsiumarvense* root and leaf extract, and it was proved that concentrated aquous extracts inhibited germination in wheat and sunflower. Kazinczi et al. (2005) demonstrated that *Cirsiumarvense* root residue significantly reduced germination of wheat. Solymosiand Nagy (1999) demonstrated that *Cirsiumarvense* affects germination of other weeds. In the mentioned experiments inhibition changed in function of the concentration. However, Rice (1964) studying allelopathy of *Xanthium italicum* observed, that inhibition is affected by the collection time of the samples, and the age of the organs extracted. Casini (2004) in Xanthium italicum observed germination inhibition on corn, in allelopathic biotests.

Materials and Methods

Meteorological data of the region from the period before the sampling was analysed (www. metnet.hu, 2009). Air temperature and relative air humidity at soil surface level, and temperature in 0.05 m depth was measured. Soil samples were taken for soil pH and consistency by Arany (Hungarian standard MSz-21470-51-83). Soil humidity was measured according to Jakucs (1980). Phenetic phase, plant density, distance between individuals were determined.

Cirsiumarvense individuals were collected near Győrújfalu, Hungary, from two adjacent ruderal edges of a maize field. (47°43'48.12N, 17°36'26.21E).The individuals were standing sparsely, one by one at the first site, and densely, bushy in a large plot at the second site. Roots, old and young leaves were collected from both sites. 12-12 g of the freshly collected samples was used to obtain allochemical or excreted material (Grodzinszkij, 1965; Brückner and Szabó, 2001). Samples were grinded and transferred to 100 mLtap water (pH 7.1) and incubated at 23-24°C, in darkness, for 24 hours, then the samples were filtered. For test plants winter wheat and maize was used. In Petri-dishes 20-20 test seeds were laid on filter paper, then for both test plants 18-18 different solutions (2 sites x 3 organs x 3 dilutions) were prepared and applied (1st day).The treatments with their abbreviations are summarized in Tables 2 and 3.

For control only tap water was added. Germination experiments were performed at room temperature in darkness, in 3 paralels. Primary or main root lengths of germs were measured on the 2nd, 3rd, 4th day (Engloner, 2007; Haraszty,

Table 3
Treatment of winter wheat seed (W)

Applied extract	First, sparsely grown site (S)	Second, densely grown site (D)				
	roots (R)	old leaves (O)	young leaves (Y)	roots (R)	old leaves (O)	young leaves (Y)
Undiluted	WSR1	WSO1	WSY1	WDR1	WDO1	WDY1
2x Dilution	WSR2	WSO2	WSY2	WDR2	WDO2	WDY2
3x Dilution	WSR3	WSO3	WSY3	WDR3	WDO3	WDY3
Control	CW					

Table 4
Treatment of maize seed (M)

Applied extract	First, sparsely grown site (S)	Second, densely grown site (D)				
	roots (R)	old leaves (O)	young leaves (Y)	roots (R)	old leaves (O)	young leaves (Y)
Undiluted	mSR1	MSO1	MSY1	MDR1	MDO1	MDY1
2x dilution	mSR2	MSO2	MSY2	MDR2	MDO2	MDY2
3x dilution	mSR3	MSO3	MSY3	MDR3	MDO3	MDY3
Control	cM					

1979). Data were analysed by ANOVA (Sváb, 1981; Izsák et al., 1982; Szűcs, 2004).

Results and Discussion

Samples were collected on 23th May, 2009. Thepreceding 2 months were extremely dry, poor in precipitation (Figures 5 and 6). Total precipitation was less than 16 mm for two months. For *Xanthium italicum* Dávid et al. (2005) observed, that plant extracts inhibited the test plants in a higher extent before a rainy period, than after it.

Air and soil (0.05 m depth) temperature was 33°C and 27°C in sparse stand, 32°C and 28°C in dense stand, respectively. Relative air humidity was 31% in sparse, 33% in dense stand.

Soil was loamy (K_A = 37), with 8.48% water content and pH = 7.5.Average height of the collected *C. arvense* individuals was 0.53 m, just before inflorescence. Distance between the individuals was 0.05-0.10 m in the dense site; number of individuals was 51/m^2. We demonstrated that all extracts inhibited test plant germination to certain extent (Table 4).

Important differences were found in the effects of the extracts. In maize, in the 2nd day all extracts restricted growth compared to control sample, on the 3rd day 83.4% was restricted, on the 4th day 61.2% was restricted. In wheat in every parallel, in every treatment growth restriction was measured.

Extracts of young leaves from the first, sparse stand of *C. arvense*exhibited a strong inhibition on maize, in dilutions their effectivity decreased slowly (Figure 7).Effect of the old leaves' extract was much weaker, in a 3-fold dilution on the 3rd day no restriction was measurable. Extracts of young leaves from the dense stand had weaker effect, which was completely lost on the 4th day. Effect of old leaves' extract from the dense stand was higher; on the 4th day inhibition was lost only in the 3-fold dilution. Root extracts of the dense stand lost their inhibiting activity proportionally to time in maize, while for the sparse stand the restriction was 60-60% for the undiluted and 2-fold, 20% for the 3-fold diluted extract, and in the later inhibition disappeared on the 4th day.

However, in our data there was no correlation, significance for the germination inhibition in maize. F value (0.67) for the 18 treatments was lower than F (1.91) at P = 0.05 for v–1=17 and v(r-1) = 36 degrees of freedom. Thus, there was no significant difference between the treatments.

In winter wheat this effect was significant (Figure 8). The calculated F value (3.09) was higher than F (1.91) at P = 0.05. Significance difference $SD_{5\%}$ is 17.4, thus, there are significant differences between the treatments.

Undiluted extract of old leaves from sparse stand restricted growth by 65% on the 2nd day, and by 55% on the 4th day. In dilutions even on the 4th day inhibited growth by 30-35%. Effect of *C. arvense* root extract from sparse

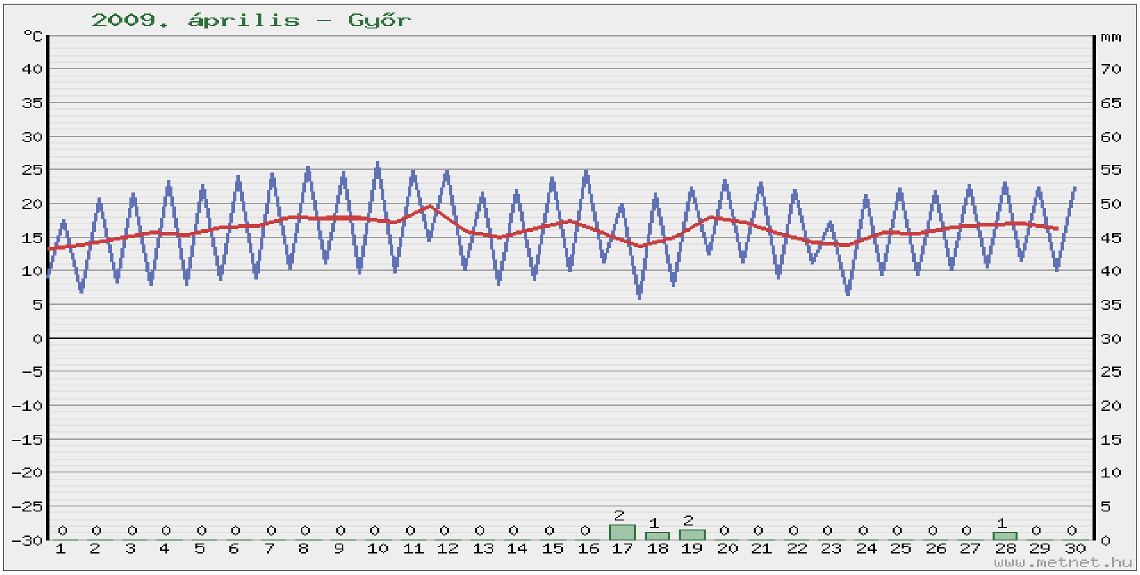

Fig. 5. Meteorological data of Győrregion in April, 2009. (www.metnet.hu)

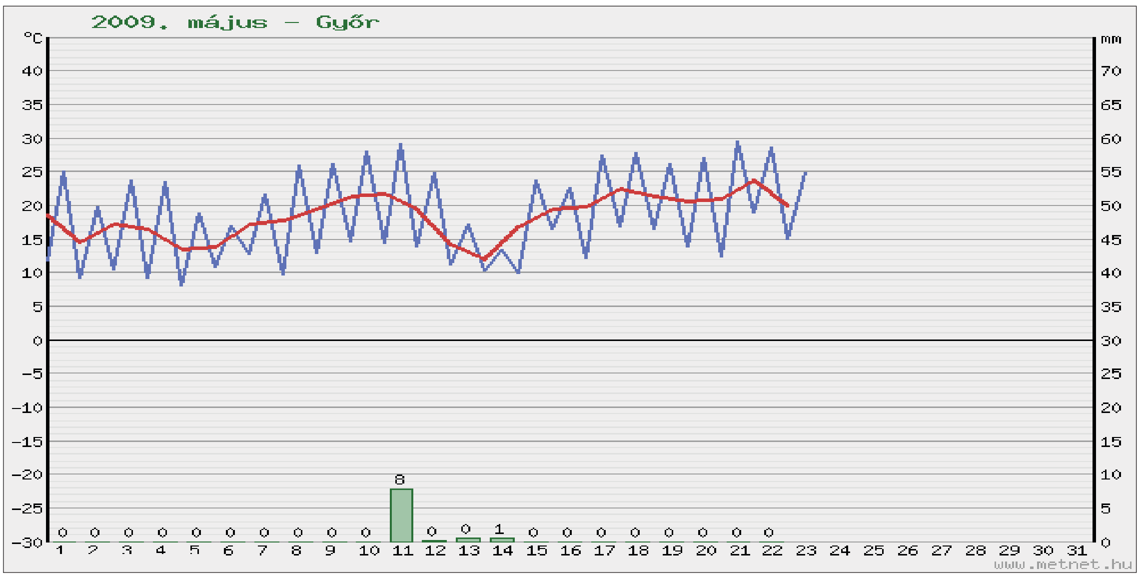

Fig. 6. Meteorological data of Győrregion in May, 2009. (www.metnet.hu)

stand is week only in the 3-fold dilution. The effect is especially significant in sparse and dense stands young leaves and roots.

Stock solution extracted of sparse stand *C. arvense*young leaves inhibited wheat germination by 99-98% on all days. In the diluted extracts this inhibiting effect was 70-50% on the 2nd and 3rd day50-40% on the fourth day. These effect has a $SD_{5\%}$ = 23.2.

Undiluted and 2-fold diluted extract of young leaves from dense stand strongly restricted growth on all days. Loss of effect was found in the 3-fold dilution, and the $SD_{5\%}$was 26.5. Root extracts exhibited strong inhibitory effect as well: in all concentrations used and on all days it exceeded 90%, with a $SD_{5\%}$value of 1.61.

We consider it important to repeat the experiments in precipitation-rich periods, and to involve some weed species

Table 5
Results of the treatments

	2nd day	3rd day	4th day			
	average length, mm	as percentage of control length, %	average length, mm	as percentage of control length, %	average length, mm	as percentage of control length, %
CM	20.6	100	39.3	100	54.3	100
MSY1	3.4	16.5	8.1	20.6	16.5	30.3
MSO1	9.0	43.6	22.0	55.9	39.6	72.9
MSR1	8.2	39.8	20.4	51.9	41.1	75.6
MSY2	11.2	54.3	22.0	55.9	42.5	78.2
MSO2	10.2	49.5	12.0	30.5	19.7	36.2
MSR2	8.1	39.3	25.8	65.6	44.4	81.7
MSY3	3.9	18.9	26.1	66.4	54.5	100.3
MSO3	10.7	51.9	39.7	101.0	78.7	144.9
MSR3	16.4	79.6	48.0	122.1	78.9	145.3
MDY1	13.4	65.0	37.3	94.9	61.3	112.8
MDO1	2.7	13.1	20.7	52.6	36.4	67.0
MDR1	6.2	30.0	19.5	49.6	31.0	57.0
MDY2	13.8	66.9	29.3	74.5	57.5	105.8
MDO2	5.7	27.6	23.0	58.5	44.5	81.9
MDR2	9.3	45.1	22.0	55.9	38.0	69.9
MDY3	6.7	32.5	29.5	75.0	60.9	112.1
MDO3	9.4	45.6	41.4	105.3	62.0	114.1
MDR3	11.0	53.3	38.0	96.6	67.8	124.8
CW	15.4	100	35.8	100	60.0	100
WSY1	0.2	1.29	0.3	0.83	0.4	0.66
WSO1	5.4	35.0	12.5	34.9	25.8	43.0
WSR1	3.0	19.4	7.3	20.3	20.3	33.8
WSY2	4.7	30.5	15.7	43.8	31.3	52.1
WSO2	7.7	50.0	19.4	54.1	38.1	63.5
WSR2	4.2	27.2	9.3	25.9	20.5	34.1
WSY3	7.6	49.3	17.0	47.4	37.0	61.6
WSO3	8.2	53.2	20.2	56.4	40.2	67.0
WSR3	14.0	90.9	29.8	83.2	48.3	80.5
WDY1	1.4	9.0	5.0	13.9	9.7	16.1
WDO1	3.5	22.7	8.1	22.6	14.8	24.6
WDR1	0.3	1.9	0.4	1.1	0.6	1.0
WDY2	4.5	29.2	12.5	34.9	26.2	43.6
WDO2	5.1	33.1	15	41.8	32.8	54.6
WDR2	0.4	2.5	1.0	2.7	2.0	3.3
WDY3	13.0	84.4	32.5	90.7	52.5	87.5
WDO3	7.0	45.4	20.0	55.8	35.0	58.3
WDR3	1.6	10.3	1.8	5.0	3.7	6.1

M=maize W=wheat C=controlS=sparsely D=dense Y=young O=old R=root 2-3 ratio of dilution

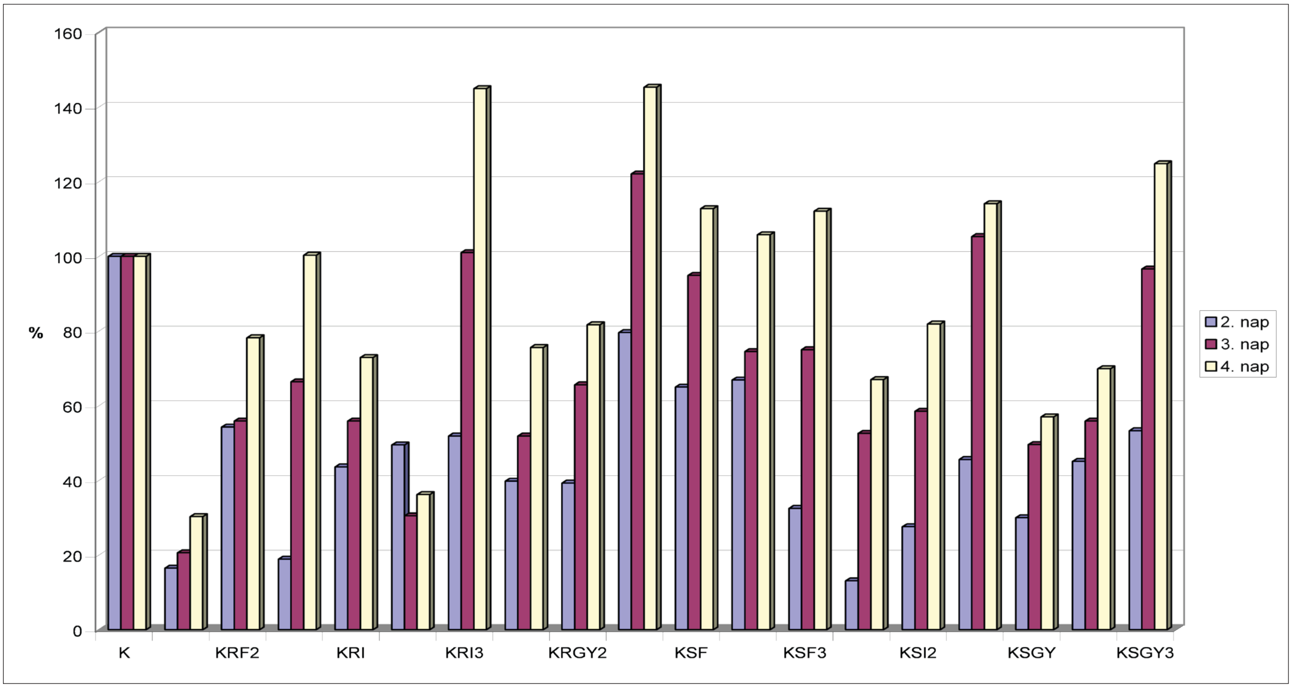

Fig. 7. Average growth of maize as percentage of the control (2 nd, 3rd, 4thday)

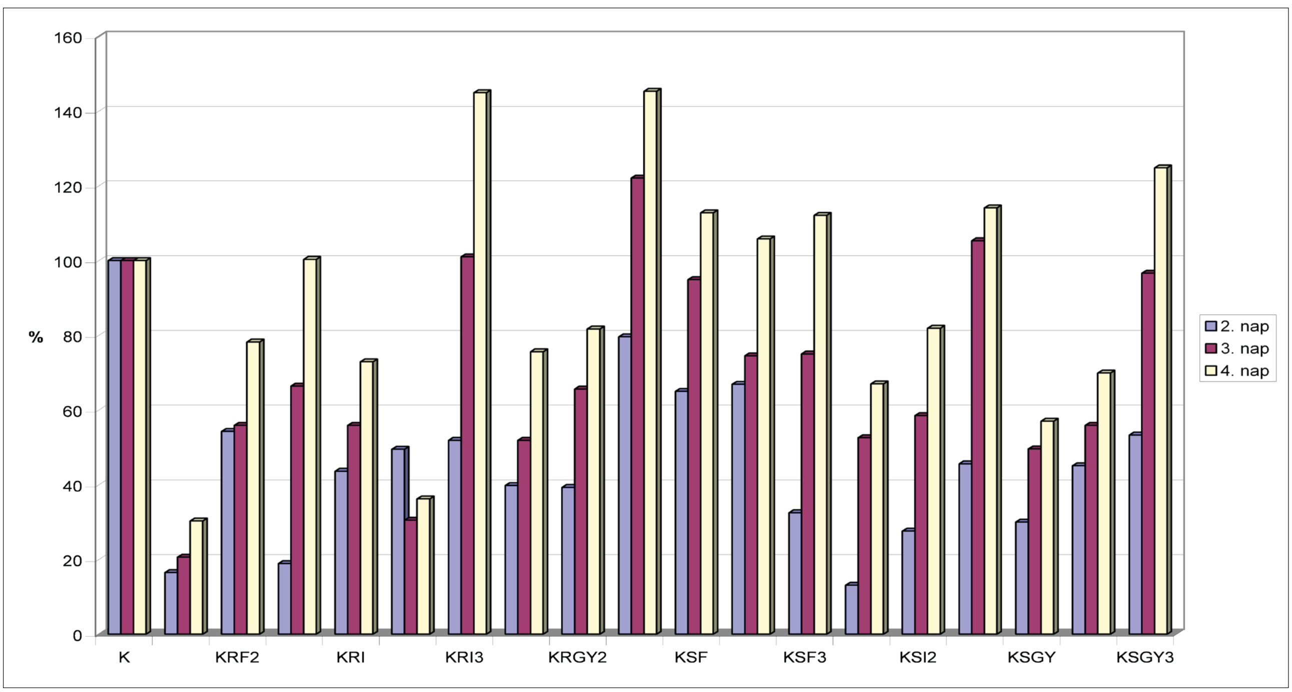

Fig. 8. Average growth of corn as percentage of the control (2 nd, 3rd , 4thday)

among the test organisms. Thus, study of allelopathic effect would cover other weeds as well.

References

Bakker, D., 1960. A comparative life-story study of *Cirsiumarvense* (L.) *Scop.* and *Tussilagofarfara* L., the most trouble some weeds in the newly reclaimed problems of the farmer Zuiderzee. In Harper J. L. (Ed.) The Biology of Weeds. Oxford. pp. 205-222.

Balázsy, S. and J. Somogyi, 2002. Practicals in Plant Physiology. *Bessenyei György Könyvkiadó*, Nyíregyháza (Hu).

Béres, I. and R. Csorba, 1992. Data to the biology of *Cirsium arvense* (L.) Scop. *Növényvédelem*, **28**: 322-327. (Hu).

Brückner, D. J. and L. Gy. Szabó, 2001. Modern interpretation of allelopathy – a review. *Kitaibelia*, **6** (1) (Hu).

Casini, P., 2004. Allelopathic influences of common cocklebur (*Xanthium italicum* Moretti) on maize. *Allelopathy Journal*, **13**: 189-200.

Czimber, Gy., M. Glemnitz, J. Hoffmann, L. Radics and Gy. Pinke, 2004. Climate change and weed flora of Szigetköz. Szigetköz Work Group of the Hungarian Academy of Sciences. Conference on the Environmental Conditions of Szigetköz, University of West Hungary, *Faculty of Agricultural and Food Sciences*, Mosonmagyaróvár (Hu).

Dancza, I., 2008. Report on the preliminary results of the 5th national weed survey of 2007-2008. 3rd Hungarian Plant Doctor Day, Corvinus University, *Faculty of Horticulture*, Budapest (Hu).

Dávid, I., M. B. Varga and L. Radócz, 2005. Change in the level of some allelochemicals in *Xanthium italicum* Mor. during the vegetation period. *Növényvédelem*, **41** (9) (Hu).

Droppa, M., S. Erdei, G. Horváth, J. Kissimon, J. Kosáry, A. Mészáros and J. Szalai, 1999. Practicals in Plant Biochemistry and Physiology. *KÉE,* Bp. (Hu).

Ellenberg, H. 1950. Unkrautgemeinschaften als Zeiger für Klima und Boden. Landwirtschaftliche Pflanzensoziologie, 1. Stuttgart/Ludwigsburg, 141 pp.

Engloner, A., 2007. Propagation and morphology of plants. In: Z. Tuba et al. (Eds.) Botanika I-III. *Nemzeti Tankönyvkiadó*, Bp. (Hu).

Grodzinszkij, A. M., 1965. Allelopathy of Plants and Their Communities. *Naukova Dumka*, Kievcit (Ru).

Hamdoun, A. M., 1972. Regenerative capacity of rootfragments of *Cirsiumarvense* (L.). *Scop. Weed Res.*, **12**: 128-136.

Hanf, M., 1982. Ackerunkräuter Europas. BASF AG. Ludwigshafen. *Klambt. and Druck GmbH.*, Speyer, 217 pp.

Haraszty, Á. (ed.), 1979. Plant Anatomy and Physiology. *Tankönyvkiadó*, Bp. (Hu).

Hegi, G., 1909. Illustrierte Flora von Mitteleuropa, VI. *Hamer*, München, 903 pp.

Holm, L. G., D. L. Plucknett, J. V. Pancho and J. P. Herberger, 1977. The World's Worst Weeds. *Cirsiumarvense* (L.) Scop. *Univ. Press of Hawai-Honolulu*, pp. 217-224.

Hunyadi, K., 1988. Weeds, weeding, weed biology. In: Hunyadi K. et al. (Eds.) Gyomnövények, Gyomirtás, Gyombiológia. *Mezőgazda Kiadó*, Bp. (Hu).

Hunyadi, K. and G. Kazinczi, 1991. Weed and man. *Növényvédelem*, **27**: (9): 403-404 (Hu).

Izsák, J., Juhász, P. Nagy and Z. Varga, 1982. Introduction to Biomathematics. Tankönyvkiadó, Bp. (Hu).

Jakucs, L., 1980. Practicals in General Nature Geography. Tankönyvkiadó, Bp. (Hu).

Johnson, B. and K. P. Buchholtz, 1902. Natural dormancy of vegetative buds on rhizome of *Agropyron repens*. *Weeds*, **10**: pp. 385-406.

Kárpáti, I., 1978. Ecological characterisation of plant species from Hungarian waters and floodplain levels. Keszth. *Agrártud. Egy. Kiadv.*, **20**: 5-62. (Hu).

Kárpáti, I. and V. Kárpáti, 1972. Practicals in Plant Geography. *Agrártud. Egy.*, Keszthely (Hu).

Kazinczi, G., I. Béres, A. Takács, J. Horváth, E. Nádasy, É. Lehoczky and T. Jancsó, 2005. Allelopathic studies in *Asclepias syriaca* L. and *Cirsiumarvense (L.) Scop. Magyar Gyomkutatás és Technológia*, **6** (1) (Hu).

Kolk, H., 1947. Gronongs biologis kastidier paogräsarter. *Wäxtodling*, (2): 108-167.

Korsmo, E., 1930. Unkräuter im Ackerbau der Neuzeit. *J. Springer*, Berlin.

Kutschera, L., 1960. Wurzeatlas Mitteleuropäischer Ackerunkräuter und Kulturpflanzen. *DLG. Verlags-GmbH.*, Frankfurt am Main, 530 pp.

Muenscher, W. C., 1960. Weeds, *McMillanComp.*, New York, 2.

Novák, R., I. Dancza, L. Szentey and J. Karamán, 2009. Weeds of Hungarian Arable Lands. Ministry of Agriculture and Rural Development, *FVM*, Bp. (Hu).

Mainé, N. M. (ed.), J. Csiszár, G. Horváth, E. Köves, A. Pécsváradi, M. Szabó, I. Tari and F. Zsoldos, 2007. Practicals in Plant Physiology, *JATEPress*, Szeged (Hu).

McAllister, R. S. and L. C. Haderlie, 1985. Seasonal variations in Canada thistle (*Cirsium arvense*) root bud growth and root carbohydrate reserves. *Weed Science*, **33**: 44-49.

Moore, R. J., 1975. The biology of Canadian Weeds 13. *Cirsiumarvense* (L.) Scop. *Can. J. Plant Sci.*, **55**: 1033-1048.

Oberdorfer, E., 1957. SüddeutschePflanzengesellschaften VEB. *Gustaw Fischer Verlag*, Jena.

Petersen, A., 1930. Taxation von Ackerlander eien Aufgrund des natürlichen Pflanzenbestandes von Ackerland und Ackerrand. *ReinholdKühn AG*, Berlin, 122 pp.

Pinke, Gy. and R. Pál, 2005. Origin, Area and Protection of Weeds. *Alexandra* (Hu).

Priszter, Sz., 1998. Our Plant Names. *Mezőgazda Kiadó*, Bp. (Hu).

Reisinger, P., 2008. Combating *Cirsium arvense* is not Hopeless. *Biokultúra*, **19**: (2): 7-8 (Hu).

Rice, E. L., 1964. Inhibition of nitrogen-fixing and nitrifying bacteria by seed plants. *Ecology*, **45**: 824-837.

Sell, P. D. and J. G. Murrell, 2006. Flora of Great Britain and Ireland, Vol. 4. *Cambridge University Press*, Cambridge, UK.

Simon, T., 2000. Determinative Manual of the Hungarian Vascular Flora. *Nemzeti Tankönyvkiadó*, Bp. (Hu).

Solymosi, P. And P. Nagy, 1999. Study of the intraspecific allelopathy of *Cirsium arvense* (L.) Scop. *Növényvédelem*, **35**: pp. 245-251 (Hu).

Solymosi, P., J. Madarász and P. Nagy, 2005. Cirsium arvense *(Cirsium arvense)*. In: Veszélyes, 48. Szerk. In: G. Benécsné et al. (Ed.) Mezőföldi Agrofórum Kft. Szekszárd, pp. 181-187 (Hu).

Suba, J., 1981. Practicals in Plant Physiology. *Tankönyvkiadó*, Bp. (Hu).

Sváb, J., 1981. Biometric Methods in Research. *Mezőgazdasági Kiadó*, Budapest (Hu).

Szabó, P., 2006. Ruderális gyomvegetáció vizsgálata a Szigetközben. PhD-disszertáció, Mosonmagyaróvár (Hu).

Szalai, J., 1981. Study of ruderal weed vegetation in Szigetköz, PhD dissertation, *University of West Hungary*, Mosonmagyaróvár (Hu).

Szűcs, I., 2004. Applied Statistics. *Agroinform Kiadó*, Bp. (Hu).

Torma, M. and K. E. Bereczkiné, 2004. Study of allelpathic effects in *Cirsium arvense (L.) Scop* és a *Sorghum halepense (L.) Pers. Magyar Gyomkutatás és Technológia*, **5** (2) (Hu).

Tóth, Á. And K. Spilák, 1998. A IV. Experiences from the 4th National Weed Survey, Keszthely, p. 49 (Hu).

Ujvárosi, M. 1973. Weeds. *Mezőgazdasági Kiadó*, Bp. (Hu).

Wehrsag, O., 1954. Ackerunkräuter. Biologie, allgemeine Bekämpfung und Einzelbekämpfung. *Akad. Verlag Berlin*, pp. 61, 102, 260.

www.metnet.hu (2009, May, 23)

Zólyomi, B. and I. Précsényi, 1964. Methode zur ökologischen Charakterisierung der Vegetationseinheiten und zum Vergleich der Standorte. *Acta Bot. Acad. Sci. Hung.*, **X**: 377-416.

Zólyomi, B., Z. Baráth, G. Fekete, P. Jakucs, I. Kárpáti, Vné Kárpáti, M. Kovács and I. Máté, 1966. Einreihung von 1400 Arten der ungarischen Flora in ökologische Gruppen nach TWR-Zahlen. *Fragmenta Botanici*, **4**: (1-4): 102-141.

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