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DOMINANT WEEDS IN MAIZE (*Zea mays* L.) CULTIVATION AND THEIR COMPETITIVENESS UNDER CONDITIONS OF VARIOUS METHODS OF WEED CONTROL

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Abstract

A field experiment was conducted in the years 2008-2010 at the Research Station of the Faculty of Agricultural Sciences, University of Life Sciences in Lublin, on brown soil with a slightly acidic pH, a high content of available phosphorus and potassium as well as an average magnesium content. The experiment was set up in a random split-plot design with four replications, with two methods for controlling weed infestation: I. mechanical – weeding of inter-rows twice; II. chemical – the herbicide Afalon Dyspersyjny 450 SC (a.i. linuron, 900 g×ha^{-1}).

Next, potassium, calcium and magnesium contents were determined in maize and in the dominant weed species. Based on the dry weight yield of maize and the biomass of particular weed species, nutrient uptake per hectare area was calculated.

The chemical method of weed control reduced both the number and dry weight of weeds more than the mechanical method. The dominant species in the maize crop were *Echinochloa crus-galli* (L.) P. Beauv., *Chenopodium album* L., *Galinsoga parviflora* Cav., and *Cirsium arvense* L. All the weed species examined were more competitive than maize in accumulating potassium, calcium and magnesium. *Galinsoga parviflora* Cav. was the most competitive species with maize for potassium, *Cirsium arvense* L. for calcium, and *Chenopodium album* L. and *Polygonum lapathifolium* L. *subsp. lapathifolium* for magnesium.

Weeds are serious competitors in taking up nutrients relative to crop plants; their share in the total uptake of macroelements from the soil by the maize crop and weeds together was considerable and it averaged as follows: for K – 35%, Ca – 27.3%, Mg –27.4%.

Key words: maize, weed control, macroelements

INTRODUCTION

Apart from variable environmental conditions, a reduction in maize yields is the result of competition from weeds (Rajcan and Swanton, 2001). The most frequently occurring species in weed infestation of maize are *Chenopodium album* L., *Echinochloa crus-galli* (L.) P. Beauv., *Amaranthus retroflexus* L., *Elymus repens* (L.) Gould, *Fallopia convolvulus* (L.) A. Löve, and *Galinsoga parviflora* L. (Gołębiowska, 2006; Głowacka, 2007). The competitiveness of weeds in nutrient uptake and their mineral composition depend, among other factors, on their species and stage of development, the degree of weed infestation of the crop, the rate of uptake and duration of the uptake period, abundance of available forms of nutrients in the habitat, cultivation techniques, and weather conditions during the vegetation period (Duer, 1986; Malicki and Berbeciowa, 1986a; Qasem and Hill, 1995; Parylak, 1996; Trąba and Wiater, 2007). In general, the total macroelement content in weeds is greater than in crop plants (Stupnicka-Rodzynkiewicz et al. 1996; Parylak, 1996).

The aim of the study was to determine the content of selected macroelements – potassium, magnesium, and calcium – in weeds dominating in maize cultivation as well as the magnitude of the uptake of these nutrients in comparison with the biomass of weeds and of maize under conditions of mechanical and chemical methods of weed control.

MATERIALS AND METHODS

A field experiment was conducted in the years 2008-2010 at the Research Station of the Faculty of Agricultural Sciences, University of Life Sciences in Lublin, on brown soil with a slightly acidic pH (pH 1 n KCl – 6.2), a high content of available phosphorus and potassium (P – 185 mg×kg^{-1} and K - 216 mg×kg^{-1}) as well as an average magnesium content (57 mg×kg^{-1}). Dent maize (*Zea mays* L.) of the Celio variety was grown on a site where spring barley had previously been cultivated. The experiment was set up in a random split-plot design with four replications, with two methods for controlling weed infestation: I. mechanical – weeding of inter-rows twice (first at the 5-6 leaf stage of maize, and again two weeks later); II. chemical – the herbicide Afalon Dyspersyjny 450 SC applied immediately after sowing (a.i. linuron, 900 g·ha^{-1}). The area of each plot was 19.8 m^2.

The mineral fertilizer was applied uniformly in the following amounts: N – 140 kg×ha^{-1} (ammonium nitrate), P – 35 kg×ha^{-1} (triple superphosphate), K – 100 kg·ha^{-1} (potassium chloride). Phosphorus and potassium fertilizers were applied once, before spring pre-sowing treatments, while the application of nitrogen was split (half before sowing and half for top dressing in the 5-6 leaf stage of maize). Maize was sown on 28 April, 4 May, and 10 May. There were 110,000 plants sown per hectare. Tillage was done according to the recommendations for maize.

The maize was harvested at the early dough stage, on 29 August 2008, 3 September 2009, and 6 September 2010. Dry weight yield was calculated per hectare. Two weeks before harvesting, weeds were collected from 1 m^2 of each plot (two sampling areas of 0.5 m^2 each). The majority of weeds were in bloom or after the bloom stage. Determinations were made of their number and botanical composition, after which they were air-dried and the dry weight of the above-ground parts of particular species was determined, as well as their total biomass. Next, potassium, calcium and magnesium contents were determined in maize and in the dominant weed species, i.e. *Chenopodium album* L. (White Goosefoot), *Galinsoga parviflora* Cav. (Gallant Soldier), *Echinochloa crus-galli* (L.) P. Beauv. (Barnyardgrass), *Cirsium arvense* L. (Creeping Thistle) and *Polygonum lapathifolium* L. *subsp. lapathifolium* (Curlytop Knotweed), following mineralization by flame atomic absorption spectrometry (PN-ISO-8288). Based on the dry weight yield of maize and the biomass of particular weed species, nutrient uptake per hectare area was calculated. The species specificity coefficient (SSC) was also determined; it expresses the ratio of the content of a given mineral component in the plant tested to the mean content in all the species tested in the plant community. A value of SSC > 1 indicates high accumulation of a given element by the species. The results of the study were analysed statistically using variance analysis, and statistical inference was performed based on Tukey's test, at a significance level of $p = 0.05$.

RESULTS

The cultivation methods applied significantly affected the degree of weed infestation in the maize crop (Table 1). Where the mechanical method of weed control was used, both the number and dry weight of weeds was greater than in the case of the chemical method. The most abundant species in maize, regardless of the weed control method applied, was *Echinochloa crus-galli* (L.) P. Beauv. It also had the greatest above-ground mass, constituting 67.7% and 80.1% of the total biomass of the weeds for mechanical and chemical weed control, respectively. The next most frequently occurring species was *Chenopodium album* L; under mechanical cultivation conditions 5 weeds.·m^{-2} were noted, while the herbicide reduced the number of plants per unit area by nearly 50%, and the air-dry weight by 68.8% (Table 1). The remaining weeds that occurred frequently were *Galinsoga parviflora* Cav., *Cirsium arvense* L. and *Polygonum lapathifolium* L. *subsp. lapathifolium*. These five dominant species constituted 84.5% of the total number of weeds growing in the maize crop.

The content of all the macroelements determined was substantially higher in the weed biomass than in the maize. Potassium content in the above-ground parts of the dominant weed species was 4.6 times higher than in the maize (Table 2). The highest potassium content among the weeds was noted in *Galinsoga parviflora* Cav. – 34.2 g×kg^{-1}dw (dry weight), and the lowest in *Polygonum lapathifolium* L. *subsp. lapathifolium* – 20.5 g×kg^{-1}dw. *Chenopodium album* L. and *Cirsium arvense* L. were the only weeds that accumulated more potassium in the plots where chemical weed control was used. Maize also accumulated more potassium where herbicidal protection was used than in the case of mechanical weed control. The amount of potassium taken up from the soil was mainly the result of the greater biomass of the maize and weeds. The maize yield was on average 10.6 t×ha^{-1} dw, while the biomass of the dominant weeds was 0.11 t×ha^{-1} dw, so the differences in potassium uptake are unsurprising (Fig. 1 and 2). The percentage share of weeds in the total uptake of this nutrient from the soil was 39.9% in the case of mechanical weed control and 17.7% where the chemical method was used. The weed species that took up the most potassium with its biomass was *Echinochloa crus-galli* (L.) P. Beauv., followed by *Chenopodium album* L. (Table 2).

The mean calcium content in the weeds was over 8 times higher than in the maize (Table 3). It was highest in *Cirsium arvense* L. and lowest in *Echinochloa crus-galli* (L.) P. Beauv. Where mechanical weed control was applied, the total uptake of calcium with the biomass of the maize and weeds together was

20.8 kg×ha^{-1}, and the percentage share of weeds in the calcium uptake was 43.8%. In the case of chemical weed control, the total calcium uptake was 18 kg×ha^{-1}. The share of weeds in the total uptake was lower, accounting for 26.6%. Among the weed species tested, the most calcium was taken up by *Echinochloa crus-galli* (L.) P. Beauv. and *Chenopodium album* L. (Table 3).

The magnesium content in the maize was 0.73 and 0.83 g×kg^{-1} dw for the mechanical and chemical methods of weed control, respectively (Table 4). The mean Mg content in the weeds was 2.50 g×kg^{-1} dw. The highest magnesium content was noted in *Chenopodium album* L. and *Polygonum lapathifolium* L. *subsp. lapathifolium*, and the lowest content in *Galinsoga parviflora* Cav. The maize with its biomass took up 7.01 and 9.63 kg×ha^{-1} of magnesium under conditions of mechanical and chemical weed control, respectively. The percentage of weeds in the magnesium uptake was 35.0% where only mechanical weed control was applied, and 19.9% when the herbicide was used. As in the case of potassium and calcium, the magnesium uptake was the result of the biomass of the maize and the weeds. Thus, the substantial magnesium uptake by *Echinochloa crus-galli* (L.) P. Beauv. and *Chenopodium album* L. is unsurprising.

The values obtained for the species specificity coefficient (SSC) also confirm the high potential of weed taxa to accumulate these elements (Table 5) in comparison with the maize. The species specificity coefficient for all the weed species tested was highest in the case of calcium.

Table 1.
Number and above-ground dry weight of weeds in maize before harvest and maize biomass in dependence of weed control methods (mean for 2008-2010)

Weed species	Number (no×m^{-2})			Dry weight (g×m^{-2})			% participation in total mass of weeds		
	I*	II	Mean	I	II	Mean	I	II	Mean
Total	35.6	19.4	27.5	148.1	90.2	119.2	100	100	100
Including:									
Echinochloa crus-galli (L.) P. Beauv	18.0	10.3	14.2	100.3	72.3	86.3	67.7	80.1	73.9
Galinsoga parviflora Cav.	3.6	1.4	2.5	5.7	0.7	3,2	3.8	0.8	2.3
Chenopodium album L.	5.0	2.7	3.8	30.2	9.4	19.8	20.4	10.4	15.4
Cirsium arvense L.	2.0	1.0	1.5	2.9	0.9	1.9	2.0	1.0	1.5
Polygonum lapathifolium L. *subsp. lapathifolium.*	2.0	1.0	1.5	0.7	2.4	1.6	0.5	2.7	1.6
Others	5.6	3.0	4.3	8.3	4.5	6.4	5.6	5.0	5.3
Maize biomass (tone dm per hectare)				9.6	11.6	10.6			

Explanation: *methods of weed control I-mechanical, II-chemical

Table 2.
Content of potassium in above-ground parts of dominant weed species and maize and its uptake by plants depending on method of weed control (mean for 2008-2010)

Species	Potassium					
	Content (g×kg^{-1} dw)			Uptake (kg×ha^{-1})		
	I*	II	Mean	I*	II	Mean
Echinochloa crus-galli (L.) P. Beauv	27.5d	28.1d	27.8C	27.6g	20.3f	24.0C
Galinsoga parviflora Cav.	34.2g	34.9g	34.6E	1.9c	0.2a	1.1B
Chenopodium album L.	29.6e	30.8f	30.2D	8.9e	2.9d	5.9D
Cirsium arvense L.	29.8e	30.7f	30.3D	0.9b	0.3a	0.6A
Polygonum lapathifolium L. *subsp. lapathifolium*	20.5c	20.9c	20.7B	0.1a	0,5ab	0.3A
Maize	6.2a	9.7b	7.9A	59.4h	112.6i	86.0E

Explanation: *methods of weed control I-mechanical, II-chemical; A, B.., a, b – means marked with the same letters do not differ significantly at p = 0.05.

Table 3.
Content of calcium in above-ground parts of dominant weed species and maize and its uptake by plants depending on method of weed control (mean for 2008-2010)

Species	Calcium					
	Content ($g \times kg^{-1}$ dw)			Uptake ($kg \times ha^{-1}$)		
	I*	II	Mean	I*	II	Mean
Echinochloa crus-galli (L.) P. Beauv.	4.7b	4.5b	4.6B	4.7d	3.3d	4.0D
Galinsoga parviflora Cav.	10.9d	11.4e	11.2E	0.6b	0.1a	0.4B
Chenopodium album L.	10.9d	10.7d	10.8D	3.3c	1.1c	2.2C
Cirsium arvense L.	15.6g	14.9f	15.3F	0.5b	0.1a	0.3B
Polygonum lapathifolium subsp. lapathifolium L	9.4c	9.8c	9.6C	0.1a	0.2a	0.2A
Maize	1.2a	1.2a	1.2A	11.7e	13.3f	12.5A

Explanation: *methods of weed control I-mechanical, II-chemical; A, B.., a, b – means marked with the same letters do not differ significantly at p = 0.05.

Table 4.
Content of magnesium in above-ground parts of dominant weed species and maize and its uptake by plants depending on method of weed control (mean for 2008-2010)

Species	Magnesium					
	Content ($g \times kg^{-1}$ s.m.)			Uptake ($kg \times ha^{-1}$)		
	I*	II	Mean	I*	II	Mean
Echinochloa crus-galli (L.) P. Beauv.	2.69e	2.72e	2.70D	2.70e	1.97d	2.33C
Galinsoga parviflora Cav.	1.55b	1.63c	1.59B	0.09a	0.01a	0.05A
Chenopodium album L.	3.05f	3.35h	3.20E	0.92c	0.31b	0.62B
Cirsium arvense L.	1.86d	1.93d	1.90C	0.05a	0.02a	0.04A
Polygonum lapathifolium L *subsp. lapathifolium*	3,12f	3.21g	3.17E	0.02a	0.08a	0.05A
Maize	0.73a	0.83a	0.78A	7.01f	9.63g	8.32D

Explanation: *methods of weed control I-mechanical, II-chemical; A, B.., a, b – means marked with the same letters do not differ significantly at p = 0.05.

Table 5.
Value of the species specificity coefficient (SSC) for maize and dominant weeds

Species	Macroelement		
	Potassium	Calcium	Magnesium
Chenopodium album L.	1.20	3.37	1.41
Galinsoga parviflora Cav.	1.39	3.89	0.72
Echinochloa crus-galli (L.) P. Beauv.	1.12	3.13	1.24
Cirsium arvense L.	1.21	3.39	0.86
Polygonum lapathifolium L. *subsp. lapathifolium*	0.83	2.33	1.44
Maize	0.25	0.70	0.34

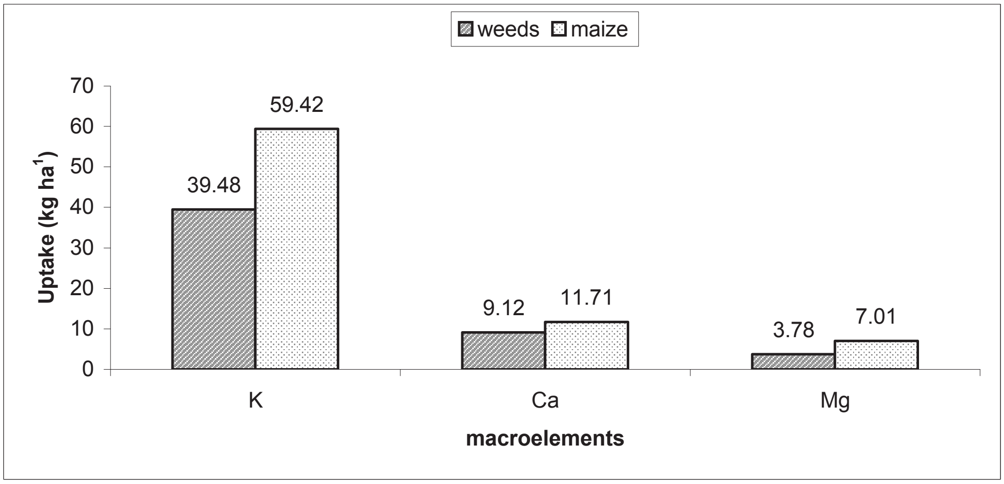

Fig. 1. Total uptake of macroelements by weeds and maize in the mechanical method of weed control

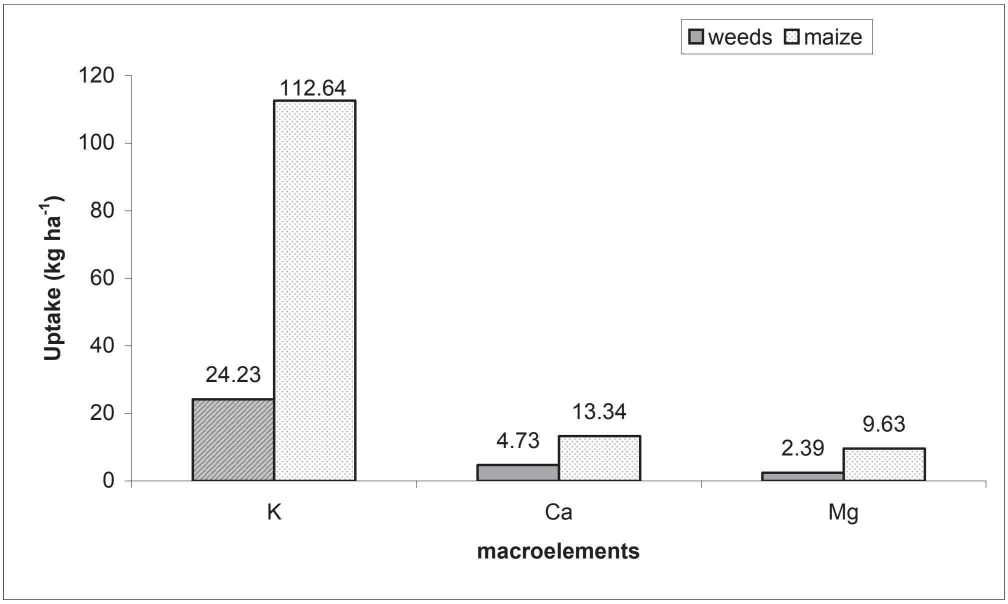

Fig. 2. Total uptake of macroelements by weeds and maize in the chemical method of weed control

DISCUSION

Maize cultivation with wide inter-row spacing is conducive to the use of mechanical methods of weed control (Raffaelli et al. 2005). Nevertheless, due to incomplete destruction of weeds in the rows of maize the mechanical method is not adequate (Abdin et al. 2000). In the present study, both the number of weeds per unit area and the dry weight of their above-ground parts were significantly higher in the plots where mechanical weed control was used than in those with herbicide protection. On the other hand, Liszka-Podkowa and Sowiński (2009) found that mechanical cultivation of maize consisting in weeding of inter-rows and earthing up twice, was more effective than a herbicide. The species occurring most frequently in maize crops are *Chenopodium album* L., *Echinochloa crus-galli* (L.) P. Beauv., *Setaria sp*., *Amaranthus retroflexus* L., *Elymus repens* (L.) Gould, and *Polygonum persicaria* L. (Kapeluszny and Haliniarz, 2002; Gołębiowska, 2006). In the present study, the dominant species in the maize crop were *Echinochloa crus-galli* (L.) P. Beauv. and *Chenopodium album* L., while *Amaranthus retroflexus* L. was not noted. *Echinochloa crus-galli* (L.) P. Beauv. is a photosynthesis C4 plant widespread throughout the world. It belongs to the grass family and is one of the most threatening weeds (Rao et al. 2007; Chauhan and Johnson, 2010). It is considered to be the main weed species in many crops, including rice (*Oryza sativa* L.), cotton (*Gossypium hirsutum* L.), maize (*Zea mays* L.), soybean (*Glycine max* L.), sorghum (*Sorghum bicolor* L.), peanuts (*Arachis hypogaea* L.), sugar cane (*Saccharum officinarum* L.), and vegetables

(Holm et al. 1991). *Chenopodium album* L. is a common weed infesting various crops on all types of soil (Skrzyczyńska et al. 2002; Trąba and Ziemińska-Smyk, 2002). Fairly abundant in the maize crop under study was *Galinsoga parviflora* Cav., which is currently very common and rather troublesome in root crops, maize, and – less frequently – cereals. It also occurs with high frequency in ruderal areas, most often in warm locations with abundant nutrients and neutral pH (Wnuk and Ziaja, 2010).

Competition of weeds with crop plants depends on their stage of development and species, abundance of nutrients in the habitat, cultivation techniques, and the crop they are growing in (Qasem and Hill, 1995; Trąba and Wiater, 2007; Gugała et al. 2009). Maize, due to its rather slow initial growth, is quite sensitive to weed competition. *Chenopodium album* L. is a particularly harmful weed, because it takes up substantial quantities of nutrients. Competition from *Chenopodium album* L. in nutrient uptake depends on soil type, fertilization, crop rotation, the species of crop plant, and its proportion in weed infestation (Stupnicka-Rodzynkiewicz et al. 1996; Parylak, 1999; Trąba and Wiater, 2004). *Chenopodium album* L. usually accumulates more mineral components than crop plants and better exploits them (Czuba and Wróbel, 1983; Wiater and Trąba, 2002). Czuba and Wróbel (1983) report that potassium content in *Chenopodium album* L. ranged from 40 to 50 g×kg^{-1} dw. Parylak (1999) found that this species, in spring triticale grown on light soil, took up potassium at the highest rate (nearly 90 g×kg^{-1} dw.) among the weeds studied. In a study by Malicki and Berbeciowa (1986b), potassium content in *Chenopodium album* L. ranged from 25.1 to 45.1 g×kg^{-1} dw, depending on the crop species it grew in (it was smaller in sugar beet, higher in spring barley). The present study found that *Chenopodium album* L. accumulated nearly 4 times more potassium than the maize, and more than *Polygonum lapathifolium* L. *subsp. lapathifolium* or *Echinochloa crus-galli* (L.) P. Beauv. However, among the dominant weed species, the most competitive in potassium uptake was *Galinsoga parviflora* Cav.

In a study by Stupnicka-Rodzynkiewicz et al. (1996), among 10 weed species examined *Chenopodium album* L. showed particularly high accumulation not only of potassium but also of calcium. Trąba and Wiater (2007) found that calcium content in *Chenopodium album* L. ranged from 9.3 to 13.7 g×kg^{-1}, depending on the crop species it grew in and on the fertilization system. A particularly strong capability of this species to assimilate calcium was also observed by Parylak (1996), who reports calcium content in *Chenopodium album* L. ranging from 14.7 to 24.2 g×kg^{-1} dw, depending on the stage of development. In the present study, calcium content in *Chenopodium album* L. was somewhat lower, at 10.3 g×kg^{-1} dw. Among the species examined, the highest amount of calcium was accumulated by *Cirsium arvense* L., and the lowest amount by *Echinochloa crus-galli* (L.) P. Beauv. Malicki and Berbeciowa (1986b) confirmed the strong capability of *Cirsium arvense* L. to assimilate calcium. Gugała et al. (2009) also found that *Chenopodium album* L. accumulated more calcium and magnesium than *Echinochloa crus-galli* (L.) P. Beauv.

The ability of different crop and weed species to take up mineral components from the soil is influenced by unequal valency and the cation exchange capacity of their roots (Drake et al. 1951). The cation exchange capacity of the roots of dicotyledons, which include *Chenopodium album* L. and *Cirsium arvense* L., is twice as high as that of monocotyledons, which include *Echinochloa crus-galli* (L.) P. Beauv. This may also explain the greater uptake of macroelements by weeds, which are mainly dicotyledons, than of maize. Similarly, Duer (1986) as well as Zawiślak and Kostrzewska (2000) observed that accumulation of nutrients was several times greater in the biomass of weeds dominated by dicotyledon species than in cereals. A confirmation of the high competitiveness of weeds with maize for Ca is the high species specificity coefficient (SSC) for this element. A value of SSC > 1 is found in taxa with high potential for accumulating calcium (Lambert et al. 1973). In the present study, 4 of the 5 weeds had SSC > 3.

The quantity of macroelements taken up by weeds is conditioned more by the size of their biomass than by the content of the nutrient in the dry mass of the species (Trąba and Wiater, 2007). This is why, as Zawiślak and Kostrzewska report (2000), in spite of a 2-3-fold higher concentration of nutrients in the mass of weeds than in the mass of rye grown in crop rotation, the macroelements taken up by the weeds constituted only 9.6% of the total amount taken up by the above-ground biomass of the crop plants and weeds together. However, in rye grown in monoculture, due to the greater biomass of the weeds, their percentage share of the macroelement uptake was as high as 34.8% and 32.5% for mechanical and chemical crop protection, respectively. Parylak (1996) determined that the percentage share of weeds in the total uptake of nutrients by barley together with the weeds accompanying it depended on the stage of development, and was greatest during the harvest maturity period of barley (35%). Liszka-Podkowa and Sowiński (2009) report that accumulation of macroelements by weeds in a maize crop varies depending on the method of weed control used. In the present study, the percentage share of weeds in the total uptake of potassium, calcium and magnesium from the soil by the maize and weeds together also depended on the weed control method used. The percentage share of weeds in the total amount of calcium taken up was as high as 43.8% where mechanical cultivation was used and 26.6% where the herbicide was applied. This resulted from the 10-fold higher calcium content in the biomass of the weeds than in the maize. The high competitiveness of weeds in accumulating calcium was also pointed out by Parylak (1996), who found that 56% of total calcium taken up by barley and the weeds accompanying it was taken up by the latter, while the corresponding figure for potassium was 36%. The present study found the competitiveness of weeds in accumulating potassium and magnesium to be smaller, but also significant. The percentage share of weeds in potassium uptake was 39.9% and 17.7% for the mechanical and chemical methods of weed control, respectively, and 35.0% and 19.9% in the case of magnesium.

CONCLUSIONS

1. The chemical method of weed control reduced both the number and dry weight of weeds more than the mechanical method. The dominant species in the maize crop were *Echinochloa crus-galli* (L.) P. Beauv., *Chenopodium album* L., *Galinsoga parviflora* Cav. and *Cirsium arvense* L..
2. All the weed species examined were more competitive than the maize in accumulating potassium, calcium and magnesium.
3. The most competitive species in nutrient uptake, due to its quantitative dominance, was *Echinochloa crus-galli* (L.) P. Beauv., which took up the most potassium, calcium and magnesium from the soil among the dominant weeds in the maize crop.
4. In terms of macroelement content in dry weight, *Galinsoga parviflora* Cav. was most competitive with maize for potassium, *Cirsium arvense* L. for calcium, and *Chenopodium album* L. and *Polygonum lapathifolium subsp. lapathifolium* L. for magnesium.

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Chwasty dominujące w uprawie kukurydzy (*Zea mays* L.) i ich konkurencyjność w warunkach stosowania różnych metod regulacji zachwaszczenia

Streszczenie

Doświadczenie polowe przeprowadzono w latach 2008-2010 w Stacji Doświadczalnej Wydziału Nauk Rolniczych Uniwersytetu Przyrodniczego w Lublinie na glebie brunatnej o odczynie lekko kwaśnym, o bardzo wysokiej zasobności w fosfor i potas oraz średniej w magnez. Doświadczenie założono w układzie losowanych podbloków, w czterech powtórzeniach, uwzględniając dwie metody regulacji zachwaszczenia kukurydzy: I. mechaniczna – dwukrotne opielanie międzyrzędzi; II. chemiczna – herbicyd Afalon Dyspersyjny 450 EC (s.a. linuron, w dawce 900 g×ha^{-1}).

W kukurydzy i dominujących gatunkach chwastów oznaczono zawartość potasu, wapnia i magnezu. Na podstawie plonu suchej masy kukurydzy oraz biomasy poszczególnych gatunków chwastów wyliczono pobranie składników z powierzchni 1 ha.

Chemiczna metoda regulacji zachwaszczenia ograniczała bardziej zarówno liczbę jak i suchą masę chwastów w porównaniu do zabiegów mechanicznych. Gatunkami dominującymi w uprawie kukurydzy były: *Echinochloa crus-galli* (L.) P Beauv., *Chenopodium album* L., *Galinsoga parviflora* Cav. i *Cirsium arvense* L. Wszystkie badane gatunki chwastów były bardziej konkurencyjne w gromadzeniu potasu, wapnia i magnezu niż rośliny kukurydzy. Gatunkiem najsilniej konkurującym o potas była *Galinsoga parviflora* Cav., o wapń – *Cirsium arvense* L., zaś o magnez – *Chenopodium album* L. i *Polygonum lapathifolium* L *subsp. lapathifolium*. Chwasty są groźnymi konkurentami w pobieraniu składników pokarmowych w stosunku do roślin uprawnych, ich udział w ogólnym pobraniu makroelementów z gleby przez łan kukurydzy był znaczny i wynosił średnio dla K – 35%, Ca – 27,3%, Mg –27,4%.