Зборник Матице српске за природне науке / Proc. Nat. Sci, Matica Srpska Novi Sad, № 115, 27—34, 2008

UDC 633.854:546.46
DOI:10.2298/ZMSPN0815027K

Rudolf R. Kastori[1, 2], *Radovan Z. Marinković*[2], *Petar Đ. Sekulić*[2], *Ivana V. Maksimović*[1, 2], *Mira M. Pucarević*[1]

[1] Faculty of Agriculture, Trg Dositeja Obradovića 8, Novi Sad, Serbia
[2] Institute of Field and Vegetable Crops, Maksima Gorkog 30, Novi Sad, Serbia

GENETIC SPECIFICITY OF MAGNESIUM NUTRITION IN SUNFLOWER*

ABSTRACT: Magnesium content was analysed in five of the most grown sunflower hybrids in Serbia, as well as in different populations of wild sunflower species: *Helianthus agrophyllus* (5), *Helianthus annuus* (4), *Helianthus neglectus* (3), *Helianthus petiolaris* (5), *Helianthus tuberosus* (5). Magnesium content in the populations of wild sunflower species ranged from 317 to 824 mg/100 g DW. The highest magnesium content was found in *Helianthus petiolaris* and the lowest in *Helianthus tuberosus*.

Different populations within each species differed significantly in magnesium content. The highest variation coefficient was found in *Helianthus tuberosus* and the lowest in *Helianthus petiolaris*.

Magnesium concentration in hybrids was significantly different as well, and in two years it was in average between 575 and 813 mg/g DW.

The results suggest that genetic variability between magnesium concentrations in wild species and hybrids of sunflower is very high. This should be taken into consideration when requirements for mineral nutrition are analysed, as well as when wild species are included in breeding programs.

KEY WORDS: sunflower, hybrids, wild sunflower species, magnesium content

INTRODUCTION

Sunflower mineral nutrition plays an important part in the effective utilization of sunflower yield potential and oil quality. Numerous research results indicate that various plant species and their genotypes are specific with respect to nutritional requirements (Epstein, 1972; Klimaševski, 1974; Sarić, 1981). Their specificity refers to the temporal dynamics of nutrient uptake,

* Овај рад је део ширих истраживања на пројекту *Акумулација, дистрибуција и физиолошко дејство итријума у вишим биљкама* Матице српске, који финансира Министарство науке Републике Србије и Покрајински секретаријат за науку и технолошки развој АП Војводине.

plant sensitivity to nutrient shortage or excess, nutrient distribution in plants, etc. (K a s t o r i, 1983). The knowledge of specific crop requirements for nutrients is important both theoretically and practically. It allows farmers to optimize plant mineral nutrition, which in turn makes room for maximum utilization of genetic yield potential of various crops and their genotypes.

Magnesium concentration in plants is under the influence of many biotic and abiotic factors such as: phase in ontogeny (R o b i n s o n, 1970, 1975), leaf part (K r s t i ć et al., 1988), plant species (K i s s et al., 2005), the number of plants per surface area, fertilization and crop rotation (K o v a č e v i ć, 1985; K a s t o r i et al., 2004), growing sites (K i s s et al., 2001). According to the results presented in the above mentioned papers, it can be concluded that different plant species and genotypes differ in magnesium accumulation depending on ecological conditions and applied technology of production, which is important when their specific needs for magnesium nutrition are considered.

In the breeding of sunflower and the other crops, "distant hybridization" or crossing with wild relatives allowed the development of new genotypes resistant to unfavorable biotic (diseases, insect pests) and abiotic (e.g. shortage or excess of nutrients, drought, high concentration of salts) factors. To facilitate the use of wild relatives, it is advisable to know their biological properties including specific aspects of their mineral nutrition. Sunflower (*Helianthus* sp.) has numerous wild relatives which differ significantly by their morphological and other traits (R o g e r s et al., 1982).

Because sunflower is behind the other crops with respect to the available knowledge of genetic requirements for magnesium in its cultivated and wild varieties, we decided to study these problems.

MATERIALS AND METHODS

The plants were grown on weakly calcareous Chernozem of good physical and chemical properties (Tab. 1). At flowering, completely developed upper leaves, which are physiologically the most active, were taken for the analyses (Ć u p i n a i S a k a č, 1989). Magnesium content was analysed in five of the most grown sunflower hybrids in Serbia, as well as in different populations of wild sunflower species from Northern America: *Helianthus neglectus (3), Helianthus petiolaris (5), Helianthus agrophylus (5) Helianthus tuberosus (5)* and *Helianthus annuus (5).* Magnesium concentration was determined by ICP. The data were statistically processed by analysis of variance, calculation of the least significant difference (LSD) and coefficient of variation using Statistica 7 Computer program.

Tab. 1 — Basic soil properties

Depth (cm)	pH		$CaCO_3$ %	Humus %	Total N (%)	AL-P_2O_5	AL-K_2O
	In KCl	In H_2O				mg/100 g	
0—30	7.19	8.22	2.76	1.96	0.154	15.0	24.1
30—60	7.37	8.26	4.56	1.95	0.142	6.6	20.0

RESULTS

Magnesium concentration in different wild sunflower species and different populations of each species are shown in the Figs. 1—5. The results suggest that analyzed wild sunflower populations differ significantly not only in their morphological features (Rogers et al., 1982), but also in their chemical composition, namely magnesium concentration. These results are in accordance with those of Krstić and Sarić (1987) who also found significant differences in chemical composition between different wild sunflower species with respect to nitrogen, phosphorus and potassium content. The highest magnesium concentration was found in *Helianthus petiolaris*, and the lowest in *Helianthus tuberosus* (Tab. 2). Different populations within each species differed significantly in magnesium content (Figs. 1—5). Magnesium concentration in analysed populations of *Helianthus neglectus* ranged between 624 and 809, in *Helianthus petiolaris* between 684 and 824, in *Helianthus agrophyllus* from 361 to 452, in *Helianthus annuus* between 542 and 694 and in *Helianthus tuberosus* between 317 and 374 mg Mg/100 g DW. The highest variation coefficient between populations within the same species was found in *Helianthus tuberosus* (4.7 mg Mg/100 g DW), the species that had the lowest magnesium concentration, while and the lowest variation coefficient was in *Helianthus petiolaris* (2.4 mg Mg/100 g DW), species that had the highest magnesium content. Magnesium content was analysed in five of the most grown sunflower hybrids in Serbia. In the two year study period magnesium concentration in hybrids varied from 575 in NS-H-111 to 813 mg Mg/100 g DW in NS-H-Krajišnik (Tab. 3).

Between the two years of study, average magnesium concentration in hybrids was not significantly different. In hybrids, average magnesium concentration was much higher than in wild species (695 compared to 561 mg/100 g DW), suggesting that during the breeding process magnesium utilization by plants was improved and its accumulation increased. Differences in magnesium concentration in sunflower hybrids were discovered earlier (Gachon, 1972).

The results suggest that genetic variability between Mg concentrations in wild species and hybrids of sunflower is very high. This should be taken into consideration when requirements for mineral nutrition are analysed, as well as when wild species are included in breeding programs.

Tab. 2 — Average magnesium concentration in wild sunflower species (mg Mg/100 g DW)

Species	Mg concentration	Coef. of variation
Helianthus agrophyllus	408^{C}	4.50
Helianthus annuus	591^{B}	3.24
Helianthus petiolaris	741^{A}	2.42
Helianthus neglectus	727^{A}	4.06
Helianthus tuberosus	339^{D}	4.72
Average	561.2	3.79
$LSD_{\alpha = 0.05}$	57.1	

Tab. 3 — Magnesium concentration in sunflower hybrids in two years of study (mg Mg/100 g DW)

Hybrids	Year		Average
	2005	2006	
NS-H-111	599^{D}	552^{D}	575
NS-H-45	729^{C}	696^{C}	713
NS-H-Bačvanin	743^{BC}	704^{C}	723
NS-H-Velja	714^{C}	591^{D}	653
NS-H-Krajišnik	806^{AB}	820^{A}	813
Average	718	672	695
$LSD_{\alpha = 0.05}$	67.5		

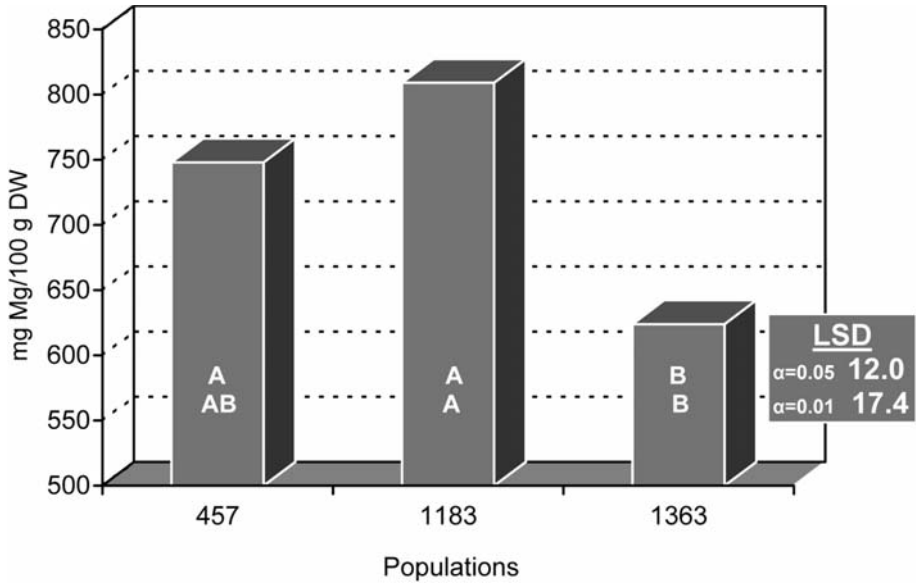

Fig. 1 — Magnesium concentration in different populations of *Helianthus neglectus*

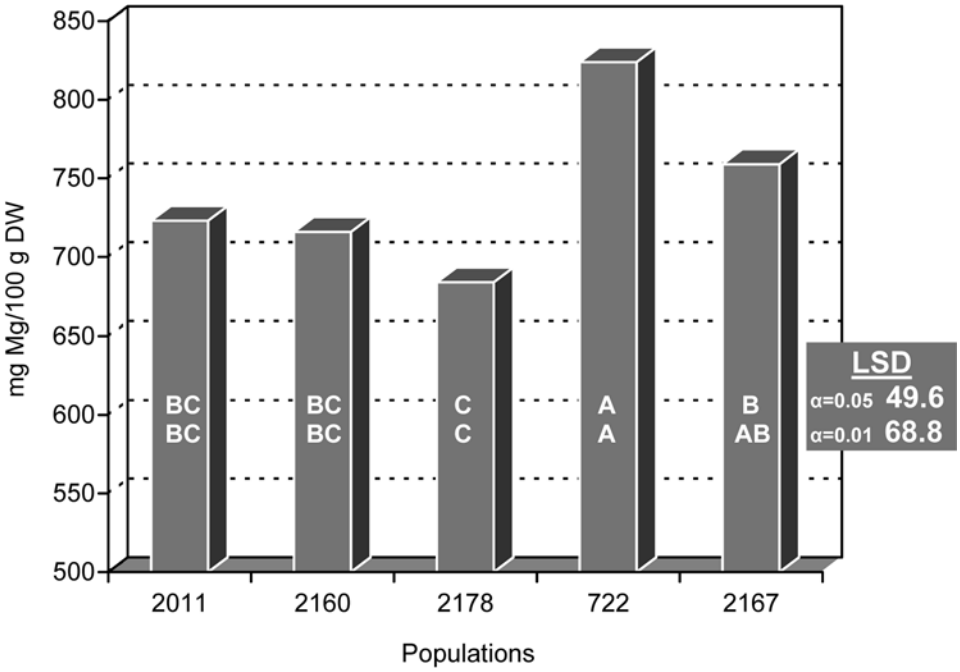

Fig. 2 — Magnesium concentration in different populations of *Helianthus petiolaris*

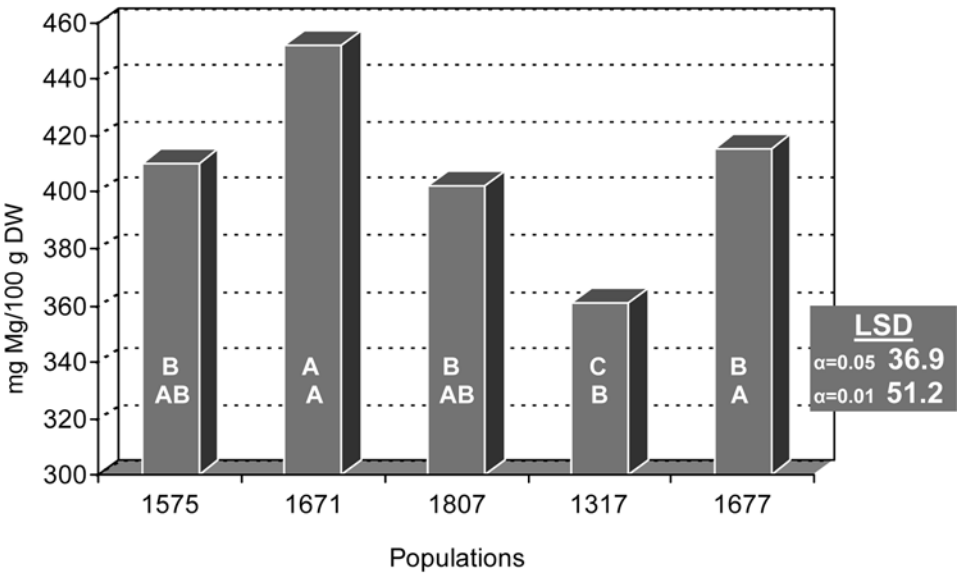

Fig. 3 — Magnesium concentration in different populations of *Helianthus agrophyllus*

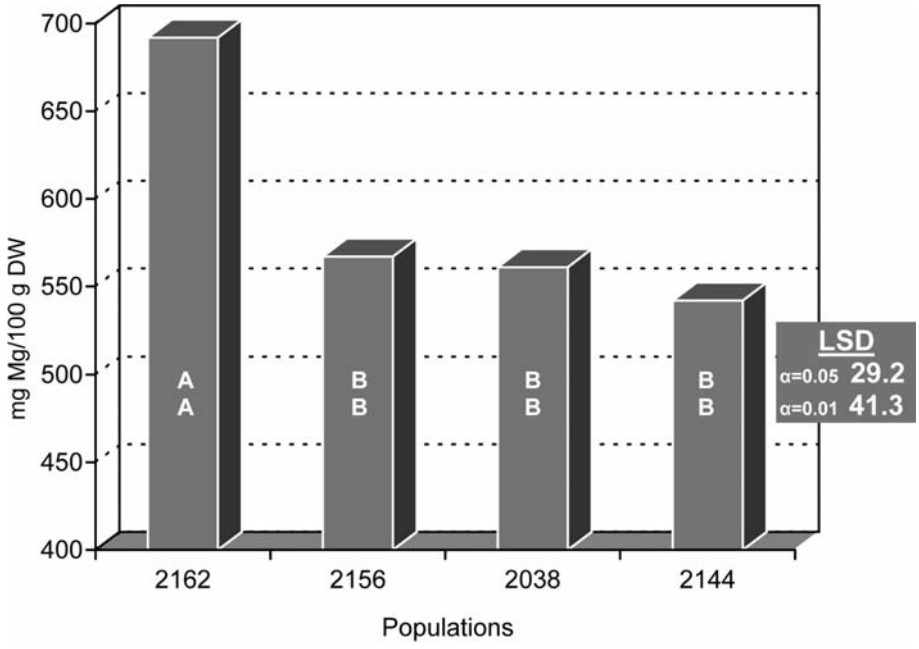

Fig. 4 — Magnesium concentration in different populations of *Helianthus annuus*

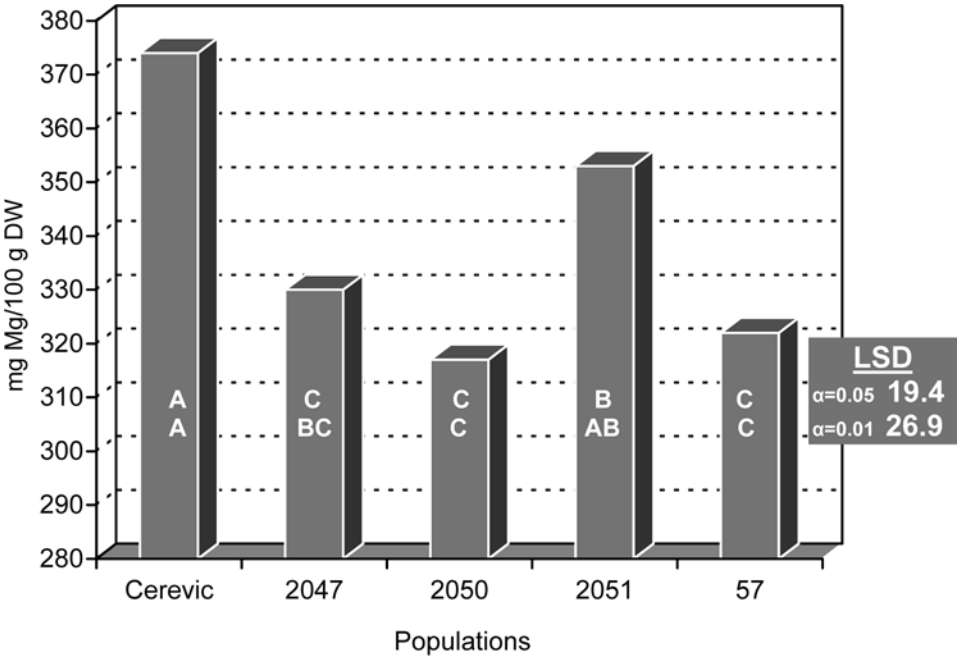

Fig. 5 — Magnesium concentration in different populations of *Helianthus tuberosus*

REFERENCES

Ćupina, T., Sakač, Z. (1989): *Fiziološki aspekti formiranja prinosa suncokreta.* Poljoprivredni fakultet, Institut za ratarstvo i povrtarstvo, Novi Sad.

Epstein, E. (1972): *Physiological genetics of plant nutrition.* In: *Mineral Nutrition of plants: principles and perspectives*. John Wiles and Sons, New York, 325—344.

Gachon, L. (1972): *La cinétique de l'absorption des éléments nutritifs majeurs chez le tournesol*, Ann. Agron. 23: 547—566.

Kastori, R. (1983): *Uloga elemenata u ishrani biljaka*. Matica srpska, Novi Sad.

Kastori, R., Molnar, I., Sekulić, P., Ralev, J. (2004): *Uticaj plodoreda i đubrenja na sadržaj magnezijuma u ozimoj pšenici.* Zbornik radova Naučnog instituta za ratarstvo i povrtarstvo, Novi Sad, 40: 203—209.

Kiss, A. S., Stefanovits—Bányai, É., Hegedüs, A., Pucarević, M., Sekulić, P., Vörösváry, G., Takács—Hájos, M. (2005). *Changes in element composition of some plant species within the Compositae family*. 9th Hungarian Magnesium Symposium, Eger, Hungary.

Kiss, A. S., Stefanovits—Bányai, É., Kastori, R., Pucarević, M., Vörösváry, G., Takács—Hájos, M. (2001): *Changes of oil and magnesium content from different growing sites collected sunflower seeds* (*Carthamus tinctorius* L.), 105—109 In: Escanero J. F. et al. (eds.) *Advances in Magnesium Research, Physiology, Pathology and Pharmacology*, 7th European Magnesium Congress, Zaragoza.

Klimaševski, L. E. (1974): *Problema genotipičeskoj specifici kornjevogo pitanije rastenii*. In: Sort i udobrenie, ANSSSR, Irkutsk, 11—53.

Kovačević, M. (1986): *Uticaj vegetacionog prostora i djubrenja na rastenje suncokreta, produktivnost fotosinteze, akumulaciju organske materije, makro i mikroelemenata.* Doktorska disertacija, Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad.

Krstić, B., Sarić, M. (1987): *Genotipska raznolikost koncentracije azota, fosfora i kalijuma divljih vrsta i inbred linija suncokreta.* Savremena poljoprivreda, 35: 193—288.

Krstić, B., Sarić, M., Jocić, B. (1988): *Koncentracija nekih makroelemenata u segmentima listova suncokreta različite starosti*. Zbornik Matice srpske za prirodne nauke, 75: 73—85.

Robinson, R. G. (1970): *Sunflower date of planting and chemical composition at various growth stages.* Agronomy Journal, 62: 665—666.

Robinson, R. G. (1975): *Elemental composition and response to nitrogen of sunflower and corn.* Agronomy Journal, 65: 318—320.

Rogers, Ch., E., Thompson, T. E., Seiler, G. (1982): *Sunflower species of the United States.* National Sunflower Association, Kaye's Inc. Fargo, Bismarck, U.S.A.

Sarić, M. R. (1981): *Genetic specificity in relation to plant mineral nutrition*. J. Plant Nutr. 3: 743—766.

ГЕНЕТСКА СПЕЦИФИЧНОСТ САДРЖАЈА МАГНЕЗИЈУМА У ДИВЉИМ ВРСТАМА И ХИБРИДИМА СУНЦОКРЕТА

Рудолф Р. Кастори[1, 2], Радован З. Маринковић[2], Петар Ђ. Секулић[2], Ивана В. Максимовић[1, 2], Мира М. Пуцаревић[2]

[1] Пољопривредни факултет, Нови Сад, Трг Доситеја Обрадовића 8, Нови Сад, Србија
[2] Институт за ратарство и повртарство, Максима Горког 30, Нови Сад

Резиме

У циљу проучавања генетске специфичности исхране сунцокрета магнезијумом испитан је садржај магнезијума у пет најраспрострањенијих хибрида сунцокрета у Србији и у различитим популацијама дивљих врста сунцокрета пореклом из Северне Америке: *Heliahnthus neglectus (3), Helianthus petiolaris (5), Helianthus agrophylus (5) Helinathus tuberosum (5)* и *Helinathus annuus (5).*

Садржај магнезијума у испитиваним дивљим врстама сунцокрета кретао се у широким границама од 317 до 824 mg/100 g суве материје. Највећи је био садржај магнезијума код испитиваних популација *Helianthus petiolaris*, у просеку 741, а најмањи код *Helinathus tuberosum*, 330 mg/1000 g суве материје. У оквиру дивљих врста испитиване популације су се такође статистички значајно разликовале у садржају магнезијума. Највећи коефицијент варијације утврђен је код *Helianthus tuberosus* а најмањи код *Helianthus petiolaris*. Садржај магнезијума се и у испитиваним хибридима сунцокрета значајно разликовао и за две године испитивања се у просеку кретао од 575 до 813 mg/100 g суве материје.

На основу добијених резултата може се закључити да је генетска варијабилност садржаја магнезијума у дивљим врстама и њиховим популацијама као и у гајеним хибридима сунцокрета веома изражена, што треба имати у виду при њиховом обезбеђењу овим елементом, као и при коришћењу дивљих врста у оплемењивачком процесу.