EFFECTS OF GROWTH STAGE AND THE SEASON ON THE MINERAL CONCENTRATIONS IN CERASTIUM HOLOSTEOIDES

VPLIV RAZVOJNEGA STADIJA IN SEZONE NA VSEBNOST MINERALOV V NAVADNI SMILJKI (CERASTIUM HOLOSTEOIDES)

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ABSTRACT

In a field trial carried out in the years 1998 and 1999 on Arrhenatheretum elatioris semi-natural mesotropic grassland, the effects of growth stage and the season on the mineral concentrations in Cerastium holosteoides were examined. Concentrations of most observed minerals (Na, P, K, Ca, Mg, Zn, and Cu) in C. holosteoides were decreasing with advancing maturity. The season significantly affected P and Mg concentrations, where values were significantly lower in summer, and Ca and Mn concentrations, where values were significantly higher in the summer than in spring. Differences in mineral concentrations between years were significant only at Mn and Zn.

KEY WORDS: Cerastium holosteoides, growth stage, mineral concentration

IZVLEČEK

V letih 1998 in 1999 smo na pol-naravnem mezotrofnem travnikih Arrhenatheretum elatioris proučevali vpliv razvojnega stadija in sezone na vsebnost mineralov v navadni smiljki (Cerastium holosteoides). Vsebnost večine proučevanih mineralov (Na, P, K, Ca, Mg, Zn in Cu) je v smiljki upadala z razvojem rastline. Vsebnost posameznih mineralov v rastlini je bila signifikantno različna v odvisnosti od sezone. Izmerjene vrednosti P in Mg so bile v poletnem času nižje, medtem ko so bile vsebnosti Ca in Mn v poletnem času višje kot spomladi. Razlike v vsebnostih mineralov med posameznimi leti so bile signifikantne le pri Mn in Zn.

KLJUČNE BESEDE: Cerastium holosteoides, razvojni stadij, vsebnost mineralov

RAZŠIRJENI IZVLEČEK

V zadnjih desetletjih znanstveniki izpostavljajo velik pomen nekaterih travniških zeli. Poleg njihove ekološke in estetske vrednoti, zeli odlikuje pomemben prispevek k pridelku krme s poudarkom na nekaterih komponentah hranljive vrednosti. Nekatere zeli vsebujejo veliko proteinov in energije, nekatere pa so pomembne v obroku živali zaradi visoke vsebnosti mineralov.

Vsebnost mineralov v rastlinah je odvisna od mnogih dejavnikov (tla, podnebni dejavniki, sezona, rastlinska vrsta, oskrba rastline,…). Eden od pomembnejših dejavnikov je razvojni stadij, ki pomembno vpliva na vsebnost mineralov v številnih krmnih rastlinah. V prvih razvojnih stadijih rastline ponavadi intenzivno kopičijo minerale v sušini. V kasnejših razvojnih stadijih pa vsebnost sušine v rastlinah narašča hitreje, kot je sprejem mineralov.

Navadna smiljka (Cerastium holosteoides) je ena od mnogih, v malem deležu prisotnih zeli v ruši. Naše poznavanje njene hranljive vrednosti je relativno skromno. Navadna smiljka prične cveteti relativno rano spomladi in tvori nove in nove cvetove na novih stranskih vejah skozi vso poletje. Za krmo to rastlino torej porabimo v različnih stadijih cvetenja in zorenja, ne glede na način izkoriščanja ruše (paša, pogostna ali le občasna košnja). Pridelek krme potemtakem vsebuje mlade in ostarele liste smiljke, cvetove in tudi plodove smiljke, kar lahko vpliva na skupno hranljivo vrednost pridelka. Posledično je bil cilj naših raziskav pridobiti več informacij o vsebnosti posameznih mineralov v smiljki, v odvisnosti od razvojnega stadija in obdobja sezone.

Raziskovalno delo je bilo izvedeno v Pernici (46° 34’ 20’’ S, 15 ° 44’ 50’’ V, 280 m nadm. viš.) pri Mariboru (Slovenija) na semi naravnem mezotrofnem travniku združbe Arrhenatheretum elatioris. Ruša je poleg drugih rastlin vsebovala tudi 3-4 % navadne smiljke. Časi vzorčenja navadne smiljke za kemijske analize so bili določeni glede na razvojni stadij pasje trave (Dactylis glomerata), in sicer v času v razraščanja (A), bilčenja (B), latenja (C), cvetenja (D) in zorenja (E) pasje trave.

Koncentracija Na se je v sušini navadne smiljke zniževala iz 0.56 v razvojnem stadiju A do 0.22 g kg^{-1} suhe snovi (ss) v stadiju E, P iz 4.1 (A) do 2.0 g kg^{-1} ss (E), K iz 33.3 (A) do 24.5 g kg^{-1} ss (E), Ca iz 7.8 (A) do 6.3 g kg^{-1} ss (E) in Mg iz 4.4 do 2.5 g kg^{-1} ss (E) (Preglednica 1). Koncentracija Zn se je zniževala 43.1 (A) do 27.1 mg kg^{-1} ss (E) in koncentracija Cu iz 10.2 do 5.6 mg kg^{-1} ss (E) (Preglednica 1). Razlike v koncentraciji Mn med posameznimi časi vzorčenja niso bile signifikantne. Izmerjene vrednosti P in Mg so bile v poletnem času nižje, medtem ko so bile vsebnosti Ca in Mn v poletnem času višje kot spomladi. Razlike v vsebnostih mineralov med posameznimi leti so bile signifikantne le pri Mn in Zn.

Obstoječi raziskava dokazuje, da je vsebnost mineralov v smiljki visoka tudi, ko rastlina že preide v cvetenje in da vsebnost večine mineralov v smiljki upada z razvojem te rastline.

INTRODUCTION

Cerastium holosteoides Fries is a short lived plant, frequent in dry and mesotropic meadows, pastures and also in fields [10]. Ellmauer and Mucina [4] classified C. holosteoides as a character-species of Molinio-Arrhenatheretea R. Tx. 1937 em. R. Tx. 1970, and a constant companion species of Sanguisorbo-Festucetum commutateae Bal.-Tul. 1959, Cirsietum rivualis Nowiński 1928, Trifolio patentis-Calthetum Kuypewr et al. 1978, Ranunculo repentis-Alopecuretum pratensis Ellmauer ass. Nova hoc loco, Filipendulo vulgaris-Arrhenatheretum Hundt et Hübl 1983, Lolio perennis-Cynosiretum Br.-Bl- et De Leeuw 1936 nom. Inv., Trifolio repentis-Veronicetum filiformis N. Müller 1988 and Crepido-Festucietum commutateae Lüdi 1948 communities. Thus, C. holosteoides is a species often found in biodiverse grassland communities, wheras usually in botanical composition it does not exceed more than a few per cent.

Hegi [10] described C. holosteoides as a less valuable forage plant, but generally in literature there is a lack of exact data about its feeding value. On the basis of existing reports it is, however, possible to conclude that it does have a certain feeding value, especially if we consider that this plant has stems and leaves less covered by hairs than other Cerastium species [8]. Bhadresa [2], for example, reported that at rabbit grazing C. holosteoides was preferred to the same extent or even more than Festuca rubra, Plantago lanceolata and Trifolium repens. In experiments of Kramberger and Klemenčič [12], C. holosteoides in dependence of growth stage contained between 69 and 153 g crude protein and between 4.1 and 6.0 MJ net energy for lactation per kg dry matter yield. The same authors also established that C. holosteoides was grazed by cows to the same extent as, on average, other species of semi-natural sward. If we also take into account its generally low proportion in botanical composition, the new value of herbs in the sward in the sense of biodiversity, and consequentially the multifunctional role of such diverse grassland areas in a rural environment, C. holosteoides is an herb which deserves a little more attention.

In the twentieth century, in the era of intensification of grassland management, a lot of dicots, especially herbs, were gradually decreasing in proportion in botanical

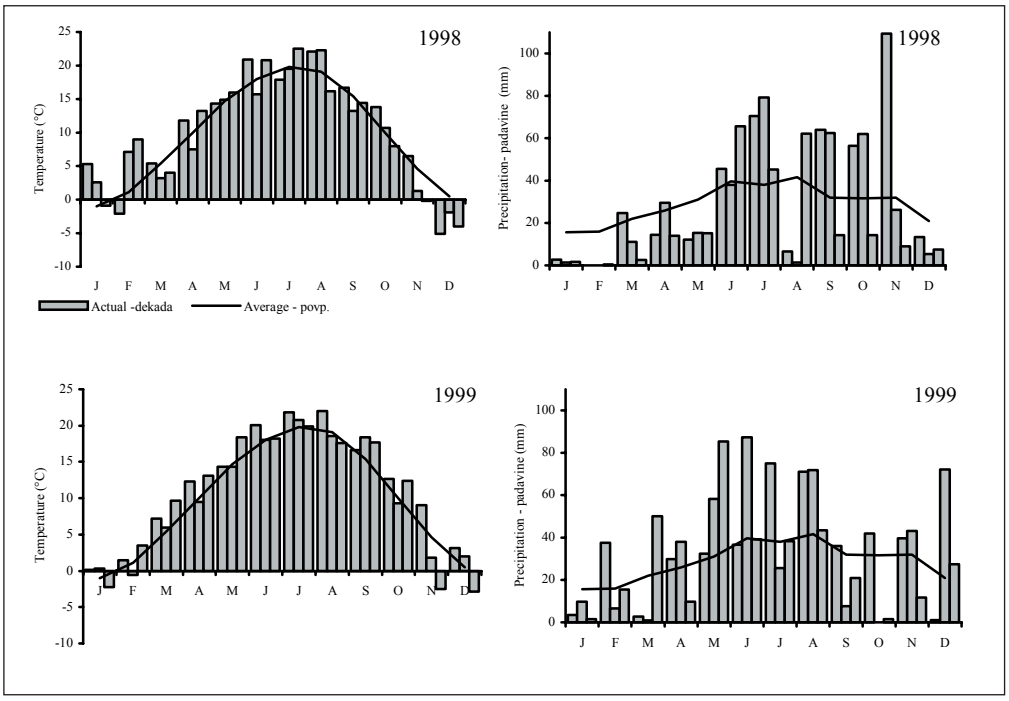
compositions of sward and in their importance for grassland utilisation. In many cases they completely disappeared from the sward. But in the last decades, with the new viewpoints on grassland and grassland management, where conservation of biodiversity gained an important role, [11], scientists have demonstrated huge usefulness of grassland herbs. Besides their ecological meaning and aesthetical value, herbs also contribute to sward yield and have important feeding value. Some of the herbs have been discovered to have high protein and energy content [15]. Due to the high concentrations of some minerals, some dicotyledonous species could also be used to increase the concentrations of some elements in the diet [3,18, 19], and many herbs can benefit the health of animals [14].

Minerals' concentration in the plants is affected by many factors, such a soil, climate, season, plant and management [17]. Another important factor is also stage of maturity, which affects the concentration of a number of minerals in forage crops. A rapid uptake of minerals by plants usually occurs during early stages of growth. Later, the dry matter content of the plant usually increases more rapidly than mineral uptake. Consequently, concentrations of many minerals in plants decrease with maturity [16]. Because of this, young leafy herbage is richer in most minerals than older stemmy material [7].

C. holosteoides is one of the many herbs represented in small percentage in the sward. Our knowledge about its feeding value is relatively low. C. holosteoides starts flowering relatively early in the spring and develops new flowers on new branches throughout the summer. We utilise these plants for forage in different stages of flowering and ripening regardless of how they are used (grazing, frequent or infrequent cutting). Outcome herbage contains young and old leaves, flowers and also fruits of this plant which can affect the feeding value of the total yield. Consequently, the objective of our work was to get more information about the effects of growth stage (different dates of harvesting) and the season on the mineral concentrations in C. holosteoides.

MATERIALS AND METHODS

The experiments were carried out at Pernica (46° 34' 20'' N, 15 ° 44' 50'' E, 280 m a.s.l.), near Maribor (Slovenia). The soil was brown earth, with a mean pH of 6.5. The average annual rainfall in the area is 1000-1100 mm (the lowest in January with only 47 mm, and the highest in



Graph 1: The average temperature (°C at 2 m above ground level) and rainfall (mm) per 10-day period for the years 1998 and 1999 and the long-term average (1951-1991).

Grafikon 1: Povprečne dekadne temperature (°C na višini 2m) in padavine v letih 1998 in 1999 in dolgoletno povprečje (1951-1991).

Table 1. Mineral concentrations in *Cerastium holosteoides* at different growth stages in first and second cuts and in both years of experiment
Preglednica 1. Vsebnost mineralov v navadni smiljki v različnih razvojnih stadijih, košnjah in letih

Treatment Obravnavanje		Mineral concentration Vsebnost mineralov							
		P	K	Ca	Mg	Na	Mn	Zn	Cu
		g kg^{-1} DM (ss)					mg kg^{-1} DM (ss)		
Growth stages (G) Razvojni stadij (G)	A	4.1a	33.3a	7.8a	4.4a	0.56a	129.9a	43.1a	10.2a
	B	3.8a	30.7ab	6.9b	3.5b	0.36b	92.4b	34.6b	8.4b
	C	3.3b	28.8bc	6.2c	2.8c	0.23bc	110.9a	33.6b	7.3c
	D	2.8c	28.2bc	6.2c	2.6c	0.32bc	119.4a	30.7c	6.3d
	E	2.0d	24.5c	6.3c	2.5c	0.22c	122.8a	27.1d	5.6d
s.e.m.		0.14	1.5	0.18	0.16	0.037	6.5	1.0	0.25
Years (Y) Leto (Y)	1	3.2a	30.5a	6.6a	3.2a	0.36a	124.1a	34.7a	7.5a
	2	3.3a	28.1a	6.7a	3.1a	0.36a	106.1b	32.9b	7.7a
s.e.m.		0.09	0.95	0.11	0.10	0.023	4.1	0.6	0.16
Cuts (C) Košnja (C)	1	3.5a	29.7a	6.4a	3.3a	0.34a	101.2a	33.8a	7.7a
	2	2.9b	28.9a	6.9b	3.0b	0.37a	129.0b	33.8a	7.5a
s.e.m.		0.09	0.95	0.18	0.10	0.023	4.1	0.6	0.16
Significance Signifikantnost									
G x Y		NS	NS	NS	NS	NS	*	*	*
G x C		*	NS	*	NS	NS	*	*	NS
Y x C		NS	NS	*	NS	NS	*	NS	NS
G x Y x C		NS	NS	NS	NS	NS	NS	NS	NS

Means within contrast values with different superscripts differ significantly (P <0.05).
Povprečja znotraj obravnavanega parametra označena z različnimi znaki se signifikantno razlikujejo (P <0.05).
NS, not significant; * P <0.05.
NS, ni signifikantno različno; * P <0.05

the summer months with 100-130 mm per month). The average yearly air temperature is 10°C, the average monthly minimum is in January with 1.3° C below zero, and the average monthly maximum is in July with approx. 20 °C. The mean number of days with an average above 0.0° C is approx 272.

As is shown in the Table 1, changes in mineral concentrations between years were significant only for manganese and zinc. On the contrary, the season of the harvesting had affected the concentrations of minerals in the herbage mass of C. holosteoides more than the years. In the C. holosteoides harvested in the summer, there was significantly less phosphorus and magnesium and significantly more calcium and manganese than in the one harvested in the spring. At other observed minerals differences were not significant. Low concentration of phosphorus in Cerastium during the summer growth is similar to some other researches of grasses and clovers, though sometimes they are lower in early summer than in mid-and late summer [17]. Reports on variation in calcium are contradictory because the content of minerals depends on many factors [17]; however, relatively high concentrations of calcium sometimes occur during periods of active growth in summer [1, 9, 17]. According to many reports [1, 9, 17], concentrations of magnesium in herbage plants are generally at their lowest in spring and increase towards autumn. However, our lower concentrations of magnesium during the summer can be result of wet weather (Graph 1) in the years 1998 and 1999, as is reported also by Fleming and Murphy [6].

The interaction G x Y was significant (P<0.05) only at three of the observed micronutrients (Mn, Zn, Cu). The interaction Y x C was significant at calcium and manganese contents and interaction G x C at calcium, manganese, zinc and phosphorus contents. The interaction G x Y x C was not significant at any minerals.

Grassland forage is an important source of minerals and may provide adequate quantities of essential minerals for ruminants. Many factors affect mineral concentration of grassland forage. A very important one is botanical

composition. It is proved by researchers [5, 18] that some herbs increase mineral concentration in grassland forage. In our experiment, growth stages A and also B were the most suitable stages for herbage mass utilisation as a forage by ruminants. In growth stage A the total herbage mass harvested from grassland used in the experiment (Arrhenatheretum elatioris Br.-Bl. 1919) contained 8.0 g Ca, 4.1 g P, 5.3 g Mg, 39.6 g K, 0.4 g Na, 33.2 mg Zn, 168.3 mg Mn and 14.6 mg Cu kg^{-1} DM. Concentrations of most observed minerals in C. holosteoides in growth stage A were near those values. During the growth stages A and B, the calcium:phosporus ratio in C. holosteoides (1.9:1 in growth stage A; 1.8:1 in growth stage B) satisfied nutritional requirement of ruminants, and was even slightly lower than in the total herbage mass of Arrhenatheretum elatioris grassland (2.0:1 in growth stage A; 1.9:1 in growth stage B). The concentrations of potassium, calcium, magnesium and manganese in C. holosteoides generally satisfied or even exceeded nutritional requirements recommended for ruminants [17]. However, concentrations of zinc, copper and phosphorus satisfied requirements [17] only in growth stage A. Later, they decreased slightly under the recommended concentrations.

Current agricultural policy has moved from only production-oriented direction toward stimulating management for high species diversity of grassland vegetation and landscapes of high aesthetical value. However, yields and the nutritional quality of forages also remain an important part of such new era management. Increasing and conservation of grassland biodiversity would be successful if each individual plant species had an important known role in the grassland sward. From a very personal view, C. holosteoides is not a species with very high aesthetical value. On the other hand, it is important in many semi-natural grassland communities where with its low proportion in botanical composition contributes to biodiverse sward.

CONCLUSIONS

The present study revealed that mineral concentrations in C. holosteoides are high when it is in the first stages of flowering, and, for a majority of observed minerals, concentration mostly decreases at stages of advancing maturity.

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