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Effect of cutting frequency on above- and belowground biomass production of *Rumex alpinus, R. crispus, R. obtusifolius* and the *Rumex* hybrid (*R. patienta* × *R. tianschanicus*) in the seeding year

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Summary

Rumex species are important weeds in grasslands and on arable land. The *Rumex* hybrid (*R. patienta* × *R. tianschanicus;* cv. OK-2, Uteusha) has been planted as a forage and energy crop since 2001 in the Czech Republic, but its ecological requirements and its potential to become a new weedy species have never been investigated. In 2010 and 2011, we performed a pot experiment to investigate the effect of none, one and two cuts per year on biomass production of *Rumex* OK-2 and common broad-leaved *Rumex* species (*Rumex obtusifolius*, *R. crispus* and *R. alpinus*). The higher cutting frequency can reduce the belowground biomass, but no effect on the aboveground biomass was detected. Flowering in the seeding year was recorded in only 50% of *R. obtusifolius* plants. Non-flowering *R. obtusifolius* plants produced significantly more belowground biomass than flowering plants under no cutting or one cut treatments. The growth response of *Rumex* OK-2 to different cutting treatments was very similar to *R. crispus*. These similarities indicate the weed potential of the hybrid to become a troublesome weedy species, similar to *R. crispus*.

Keywords: broad-leaved dock, curled dock, monk's rhubarb, grassland management, mowing frequency, *Rumex* OK-2.

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Introduction

Rumex obtusifolius L. subsp. *obtusifolius* (broad-leaved dock; hereafter referred as *R. obtusifolius*) and *Rumex crispus* L. (curled dock) are considered to be among the most widely distributed non-cultivated weedy species in temperate zones worldwide (Holm *et al.*, 1977; Grime *et al.*, 1988; Zaller, 2004; Stilmant *et al.*, 2010; Hrdličková *et al.*, 2011; Hejcman *et al.*, 2012c). *Rumex obtusifolius* is a very important perennial weed in grasslands (Strnad *et al.*, 2010), whereas *R. crispus* is considered to be a serious weed on arable land and in highly disturbed areas because of its short life span and rather monocarpic character (Cavesr & Harper, 1964; Hejcman *et al.*, 2012a). In addition to the above-mentioned species, *Rumex alpinus* L. (monk's rhubarb) is a troublesome perennial weed in high mountains of western, central and eastern Europe and is common in

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abandoned grasslands (Šťastná *et al.*, 2010). A new *Rumex* crop hybrid of *R. patienta* L. × *R. tianschanicus* Losinsk., registered as *Rumex* cv. OK-2, has been developed for use as a forage and energy (biofuel) crop. In this article, it is referred to as *Rumex* OK-2, but is also known as 'Uteusha' in the Czech Republic (Usťak, 2007) after its Ukrainian breeder, Prof. Uteusha. *Rumex* OK-2 has also recently been introduced into several other European countries, including Germany, Slovakia, Bulgaria and Norway. It has been recorded as having escaped from arable fields into surrounding grassland and has the potential to become a new invasive weedy species (Hujerová, 2010; Pyšek *et al.*, 2012).

Rumex obtusifolius creates a deep taproot with high storage capacity for assimilates and nutrients. It develops a root collar with high regeneration ability following disturbance and with a high potential for clonal reproduction (Pino *et al.*, 1995; Strnad *et al.*, 2010). In addition to generative reproduction, *R. obtusifolius* can expand through a phalanx clonal growth strategy, resulting in a dense nest of ramets that can occupy an area of several tens of square metres around the mother plant (Pino *et al.*, 1995). Individual plants can survive in the grassland sward for more than 8 years, although a high proportion can die within 5 years under conditions of low N, P and K availability and no grassland management (Pavlů *et al.*, 2008; Martinková *et al.*, 2009; Hujerová *et al.*, 2011; Hann *et al.*, 2012; Hejcman *et al.*, 2012a). *Rumex obtusifolius* regrows well after cutting (Martinková & Honěk, 2001) and therefore does not suffer under a management system of cutting performed twice per year (Strnad *et al.*, 2012). Suitable conditions for its growth are high nutrient availability in the soil interacting with reduced competition from other sward components, such as occurs by regular defoliation management or by sward disturbances (Gaisler *et al.*, 2010; Křišťálová *et al.*, 2011; Hejcman *et al.*, 2012a). *Rumex obtusifolius* can tolerate a high cutting frequency for several years. Therefore, neither two nor three cuts per year are sufficient for its elimination from grassland (Niggli *et al.*, 1993; Hopkins & Johnson, 2002; Stilmant *et al.*, 2010; Hann *et al.*, 2012; Strnad *et al.*, 2012).

Rumex crispus has a lower competitive ability in permanent grasslands than *R. obtusifolius*, due to its dependence on regular regeneration from seeds and its high sensitivity to regular cutting management (Hejcman *et al.*, 2012a,b; Strnad *et al.*, 2012). According to Hongo (1988) and Bond *et al.* (2007), poor regrowth of *R. crispus* after cutting, compared with the more rapid and highly intensive regrowth of *R. obtusifolius*, is connected to its lower investment into belowground organs.

Rumex alpinus is a rhizomatous perennial species and is typically associated with grassland on mountainous sites that have either no or extensive defoliation management and high nutrient availability (Bohner, 2005; Šťastná *et al.*, 2010). Its horizontal monopodial rhizome is formed by a shortened base of a shoot and grows at a depth of up to 5–10 cm (Klimeš, 1992). A new segment of the rhizome develops each year. Therefore, the growth of the plant and its age, which can be as much as several decades, can be determined from the number of segments (Šťastná *et al.*, 2012). Although *R. alpinus* is able to regrow after being cut, it cannot withstand long-term and regular cutting management, and it seldom occurs in regularly cut grasslands (Šťastná *et al.*, 2010).

The hybrid *Rumex* OK-2 is described as a perennial (up to 10 years) stress-tolerant plant, characterised by high ecological plasticity, with cold and winter hardiness and high tolerance to salt stress and soil moisture (Kosakivska *et al.*, 2008). Although *Rumex* OK-2 has been planted since 2001 in the Czech Republic, its detailed ecological requirements and its potential to become a new weedy species have never been investigated. In addition, there is no information about its basic ecological requirements.

Therefore, the present study addressed the following research question: Are there differences in basic growing characteristics between *Rumex* OK-2 and weedy *Rumex obtusifolius*, *R. crispus*, *R. alpinus* under different cutting regimes? Using a pot experiment, we tested differences in aboveground and belowground biomass production and in the ratio of belowground and aboveground biomass in the first year of growth. The comparison of growing parameters of *Rumex* OK-2 with the other broad-leaved *Rumex* species could help to assess its potential to become a new weedy species.

Materials and methods

Study site and design of the pot experiment

The pot experiment was conducted in 2010 and 2011 at the experimental garden of the Crop Research Institute, Grassland Research station Liberec, northern Czech Republic (50°46′33.213″N, 15°2′20.207″E; altitude 366 m a.s.l.) under conditions of natural rainfall, temperature and daylight. Mean annual temperature at the study site was 7.5°C and average annual precipitation was 800 mm. Monthly rainfall and mean air temperature at Liberec Meteorological Station during the vegetation seasons 2010–2011 are given in Table 1. We compared *Rumex* OK-2 with three *Rumex* species (*Rumex obtusifolius*, *R. crispus* and *R. alpinus*) under three cutting frequencies: no cut (0C), one cut in July

Table 1 Monthly precipitation sum and mean air temperature at Liberec meteorological station during the experimental period and 30-year mean values

	Rainfall (mm)			Air temperature (°C)		
Month	2010	2011	Average 1966–1995	2010	2011	Average 1966–1995
June	81	75	85	15.6	16.3	15.5
July	296	149	88	19.7	15.9	16.1
August	87	376	88	16.5	17.6	16.2
September	65	170	65	14.5	14.5	12.7

(1C) and two cuts per vegetation season in July and August (2C). The frequency and timing of cutting treatments were based on the typical agricultural practice in the area. Each treatment was replicated five times (thus, 60 pots in total). The same type of soil and pots were used in both study years as the experiment was established two times, in spring 2010 and again in spring 2011.

Seeds of *R. obtusifolius*, *R. crispus* and *R. alpinus* were collected from plants in grassland near Liberec, abandoned fields near Prague and in abandoned grasslands in the Jizera Mts., respectively, in autumn 2008. Seeds of *Rumex* OK-2 were obtained as a commercial product (Crop Research Institute, Centre for Revitalization and Sustainable Development of North Bohemia, Chomutov). Tested germination was about 90% for all studied species. The one-month old seedlings (one per pot) were transplanted into pots at the end of May 2010 and 2011. We used 40-cm-diameter conical pots (30 cm diameter at base), and the pot volume was 30 L. In both years, we used the same cambisol in the experiment, as this is the most common soil type on the sites where seeds of the *Rumex* had been collected. The soil was collected in 2010, and it had the following chemical properties: pH_{KCl} = 5.5, P = 122 mg kg^{-1}, K = 234 mg kg^{-1}, Mg = 91 mg kg^{-1}. The pots were refilled with fresh soil in year 2011. The P, K and Mg were extracted by Mehlich III reagent to determine plant-available concentrations. During the vegetation season, *Rumex* plants were watered when necessary to avoid any water stress. The position of individual pots was changed at weekly intervals to avoid any site and edge effects.

Data collection

At each cutting date, the aboveground biomass of *Rumex* plants (shoot, leaves) was cut to 2 cm height above soil surface, then dried at 60°C for 48 h and weighed. Finally, the total aboveground and belowground biomass was taken in all treatments in September 2010 and again in 2011 and then weighed. Aboveground biomass was collected in the same way as the regular cuts. In addition, we recorded the presence of inflorescences in individual plants. Belowground biomass was determined after rinsing the roots free of soil using a water spray. The roots were then dried at 60°C for 48 h, and weight of dry matter was determined. The belowground/aboveground biomass ratio was calculated to determine the response of biomass allocation under the different cutting treatments.

Data analyses

Factorial ANOVA was used to test the effects of year, species, cut and their interactions on the aboveground biomass, belowground biomass and belowground/aboveground biomass ratio. We tested the following effects: year, species, cut and their interactions. One-way ANOVA was then used to test differences among species for particular cutting frequencies and among cutting frequencies for individual species. Calculation was conducted separately for each year. *Post hoc* comparison using the Tukey's HSD test was applied to identify significant differences between species and individual treatments. The data met all requirements of ANOVA. The relation between aboveground and belowground biomass was evaluated using the Pearson's correlation coefficient.

Results

Aboveground biomass

Effect of year and interaction of species × year and cut × year were significant on aboveground biomass production (Table 2). In contrast, there were no significant effects of cut, species and of the species × cut interaction on aboveground biomass production. The aboveground biomass production of all the studied species under all cutting frequencies was higher in the second year than in the first year of the experiment (Fig. 1).

In the first year, there were only small differences between the species in their aboveground production. *Rumex alpinus* was the only species that constantly

Table 2 Results of factorial ANOVA (Year was random factor) calculated for belowground biomass, aboveground biomass and belowground/aboveground biomass ratio

Tested variable	Effect	DF	*F* value	*P* value
Aboveground biomass	Year	1	10.74	*0.026*
	Species	3	1.50	0.374
	Cut	2	0.11	0.902
	Species × Year	3	13.11	*<0.001*
	Species × Cut	6	1.01	0.426
	Cut × Year	2	6.65	*0.002*
Belowground biomass	Year	1	24.99	*0.015*
	Species	3	3.48	0.167
	Cut	2	31.65	*0.031*
	Species × Year	3	3.03	*0.033*
	Species × Cut	6	6.92	*<0.001*
	Cut × Year	2	1.63	0.200
Belowground/aboveground biomass ratio	Year	1	201.5	0.286
	Species	3	19.7	0.273
	Cut	2	0.73	0.086
	Species × Year	3	13.11	*0.002*
	Species × Cut	6	1.01	*0.031*
	Cut × Year	2	6.645	*<0.001*

DF, degrees of freedom.
Significant results are in italics.

tended to have the lowest amount of shoot growth under all cutting frequencies (Fig. 1). In the second year, *Rumex* OK-2 tended to have the weakest shoot growth in all treatments. Its aboveground biomass production was significantly lower than that of *R. obtusifolius* in all treatments.

Belowground biomass

The effect of year, cut and the interaction of species × cut and species × year were significant on belowground biomass production (Table 2). In contrast, there was no significant effect of species and cut × year interaction on belowground biomass production. The belowground biomass production of all the studied species under all cutting frequencies was higher in 2011 than in 2010 (Fig. 1). The highest belowground biomass from all studied species and cutting frequencies was recorded for *Rumex* OK-2, followed by *R. crispus* under no-cutting management in 2010; the same trend was observed in 2011 (Fig. 1). On the other hand, the lowest values of belowground biomass under the no-cutting management were recorded for *R. obtusifolius* and *R. alpinus* in 2010, and a similar tendency was recorded in 2011. Although *Rumex* OK-2 and *R. crispus* produced the greatest amounts of belowground biomass under the no-cutting management, there was a strong negative effect of both the one-cut and two-cut management on their belowground biomass production (Fig. 1). This negative effect contrasted with the absence of an effect of one-cut or two-cut management on belowground biomass production of *R. obtusifolius* in both years, and on belowground biomass production of *R. alpinus* in the second year.

There were no differences between *Rumex* species under the one-cut management in either year (Fig. 1) or under the two-cut management in the first year of the experiment. In the second year, belowground biomass was highest for *R. crispus*, followed by *R. obtusifolius*, and lowest for *Rumex* OK-2, followed by *R. alpinus* under the two-cut management.

Belowground/aboveground biomass ratio

Effects of species × year, cut × year and species × cut interactions on the belowground/aboveground biomass ratio were significant (Table 2). In contrast, there was no significant effect of cut, year and species on belowground/aboveground biomass ratio. The ratio generally tended to be highest in the *Rumex* OK-2, particularly in the second year of the experiment, when it was significantly higher under no-cut and one-cut management than in all other species (Table 3). Decreasing ratios between below- and aboveground biomass under increasing cutting frequencies, as measured for *Rumex* OK-2 and *R. crispus*, were also recorded for *R. alpinus*.

With the exceptions of *R. obtusifolius* under no-cut and one-cut management and *Rumex* OK-2 under the no-cutting management, there was clearly a linear and highly positive relationship between belowground and aboveground biomass production for all *Rumex* species and under all cutting frequencies (Fig. 2). In the seeding year, flowering was recorded only in plants of *R. obtusifolius*. Over both years, the proportion of flowering plants of *R. obtusifolius* was 60%, 40% and 50% under management of no cutting, one cut and two cuts respectively. Flowering plants produced almost the same amount of aboveground biomass as non-flowering plants, but they produced substantially lower amounts of belowground biomass particularly under no-cut and one-cut management (Fig. 3). Flowering thus substantially decreased the belowground/aboveground biomass ratio in *R. obtusifolius* plants (Table 4).

Discussion

There were large differences in the biomass production of all *Rumex* species between the 2 years of the experiment, despite the pots having been watered in both years to avoid water stress. It is possible that surplus precipitation may have affected the biomass production of *Rumex* species in year 2011.

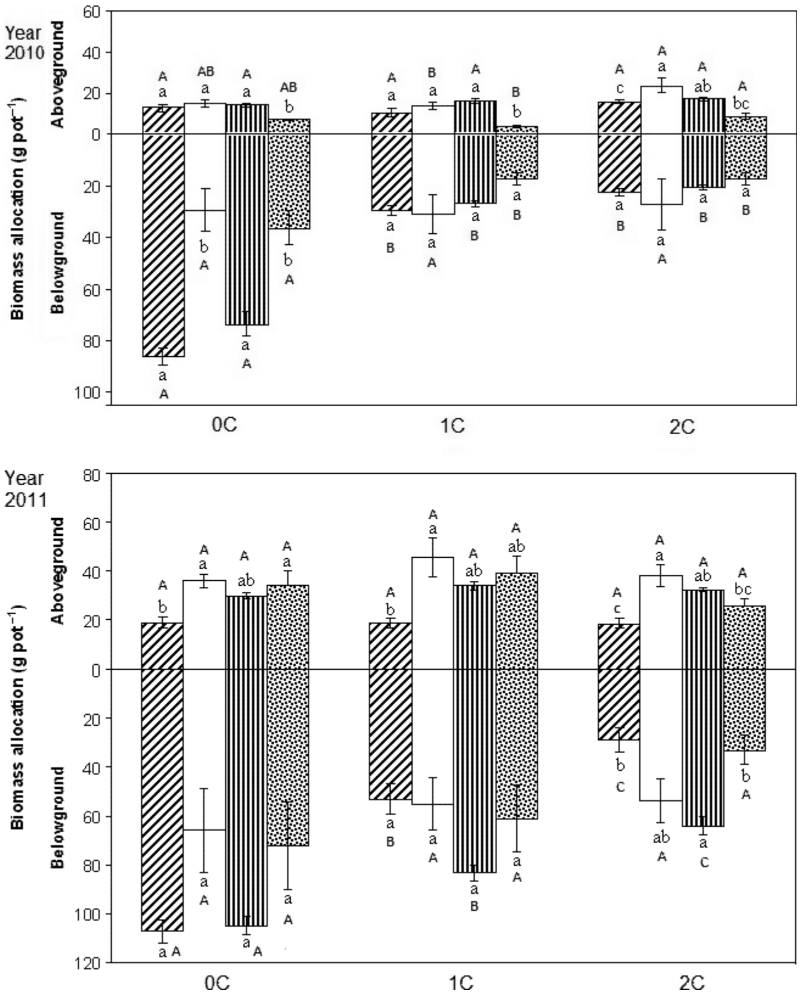

Fig. 1 Biomass dry matter allocation (g per plot) of *Rumex* species (▨*Rumex* OK-2, ▭ *R. obtusifolius*, ▥ *R. crispus*, ▩*R. alpinus*) under different treatments (0C-no cut; 1C-cut once; 2C-cut two times) in years 2010 and 2011. Significant differences ($P < 0.05$) between *Rumex* species in each treatment according to the Tukey's *post hoc* test are indicated by different small letters and significant differences ($P < 0.05$) between treatments for each *Rumex* species according to the Tukey's *post hoc* test are indicated by different capital letters.

Table 3 Belowground/aboveground biomass ratio of *Rumex* species under different treatments in 2010 and 2011

		Treatment		
Year		No cut	One cut	Two cuts
2010	*Rumex* OK-2	7.29 ± 1.35 a A	3.60 ± 1.21 ab AB	1.45 ± 0.09 a B
	R. obtusifolius	1.97 ± 0.52 b A	2.26 ± 0.56 ab A	1.16 ± 0.45 a A
	R. crispus	5.29 ± 0.48 ab A	1.68 ± 0.14 b B	1.19 ± 0.03 a B
	R. alpinus	5.43 ± 1.58 ab A	4.74 ± 0.63 a A	2.36 ± 0.67 a A
2011	*Rumex* OK-2	5.99 ± 0.78 a A	2.82 ± 0.14 a B	1.52 ± 0.15 ab B
	R. obtusifolius	1.97 ± 0.57 b A	1.47 ± 0.41 b A	1.40 ± 0.17 b A
	R. crispus	3.50 ± 0.08 b A	2.48 ± 0.15 ab B	1.99 ± 0.11 a
	R. alpinus	2.02 ± 0.18 b A	1.58 ± 0.25 b AB	1.25 ± 0.14 b B

Numbers represent average of five replicates, ± standard error of the mean (SE). Significant differences ($P < 0.05$) between treatments for each *Rumex* species according to the Tukey's *post hoc* test are indicated by different capital letters in row and significant differences ($P < 0.05$) between *Rumex* species in each treatment according to the Tukey's *post hoc* test are indicated by different small letters in column.

Aboveground biomass

The ability of *R. obtusifolius* to flower in the seeding year and to produce sterile and flowering plants is consistent with results of other pot or field experiments performed in the Czech Republic (Hrdličková *et al.*, 2011; Křišťálová *et al.*, 2011; Hejcman *et al.*, 2012b; Strnad *et al.*, 2012). In contrast, *R. crispus* was not

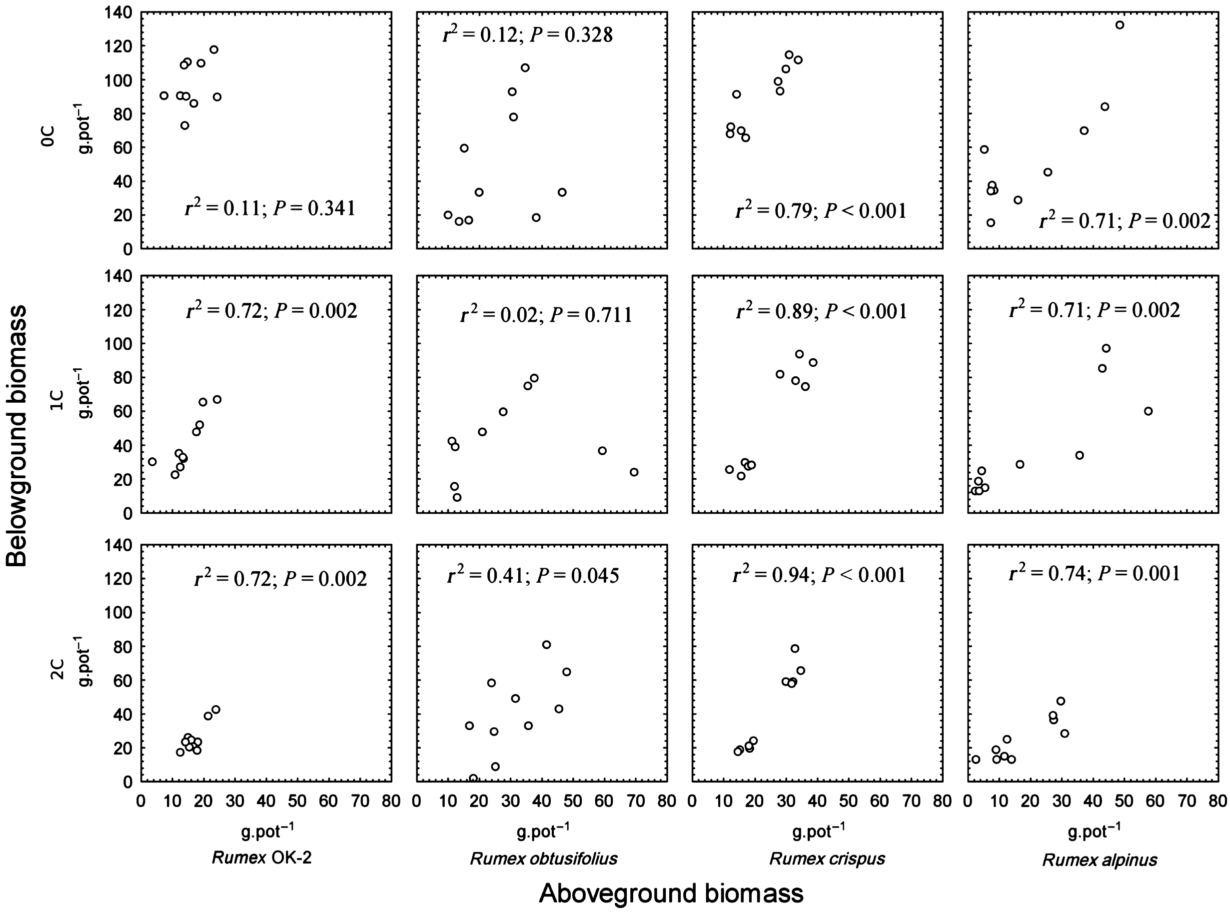

Fig. 2 Relationship between belowground and aboveground biomass of *Rumex* species under different treatments (0C-no cut; 1C-cut once; 2C-cut two times) during the experiment. Pearson's correlation coefficients and probability levels are presented inside each subfigure.

able to produce any seeds in the seeding year. This finding supports the results of several experiments in the Czech Republic, which showed that the absence of flowering in the seeding year was a matter of genetics, rather than a consequence of insufficient nutrient availability (Křišťálová *et al.*, 2011; Hejcman *et al.*, 2012a, b; Strnad *et al.*, 2012).

Rumex crispus is thus substantially more sensitive to unpredictable environmental conditions than *R. obtusifolius*, as it needs at least 2 years to produce seeds. The absence of flowering and seed production in the seeding year might be one of several reasons that explain why *R. crispus* is a substantially less common species than *R. obtusifolius* in Central Europe.

From all the studied *Rumex* species, the highest year-to-year variability in biomass production was recorded for *R. alpinus*. Lower biomass production in 2010 (7.2 g for 0C, 3.8 for 1C and 9.0 for 2C) than in 2011 (34.2 g for 0C, 39.5 for 1C and 25.8 for 2C) was probably caused by heat stress, as there were fewer cloudy and rainy days, and temperature was higher in summer 2010 than in 2011. High sensitivity of *R. alpinus* to heat stress might be a reason why this species is common at high altitudes and generally missing in the lowlands (see also Šťastná *et al.*, 2010).

Rumex OK-2 did not show the highest amount of aboveground biomass production, despite its recommended use as a forage and energy crop on the basis of its high herbage production (Usťak, 2007). Over the short duration of the investigation reported here, the growth potential of *Rumex* OK-2 was not different to that of common *Rumex* weedy species under low or medium nutrient availability in the soil. The aboveground biomass production of *Rumex* OK-2 might be higher under high soil nutrient availability, but this was not investigated in this experiment. Furthermore, one vegetation season may have been insufficient for the *Rumex* OK-2 to have reached a growth stage that would have allowed its production to proceed. Under adequate growing conditions, its relatively high belowground allocation in the establishment phase might be an advantageous strategy in the long-term. Although Hopkins and Johnson (2002) recorded the highest aboveground biomass production of *R. obtusifolius* under

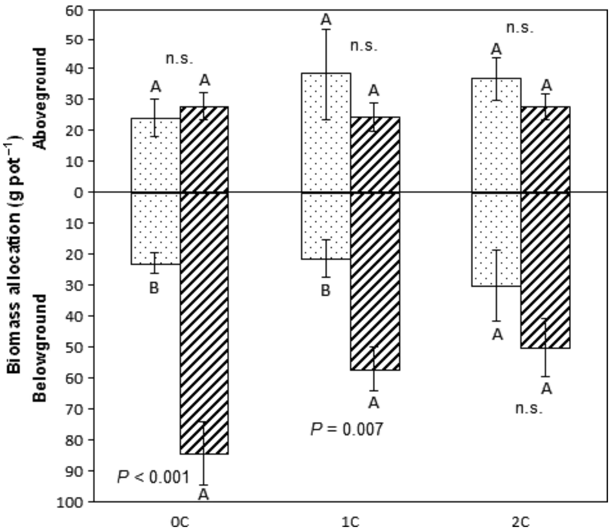

Fig. 3 Biomass dry matter allocation (g per plot) of *Rumex obtusifolius* with flowering (▨) and *R. obtusifolius* without flowering (▨) under different treatments (0C-not cut; 1C-cut once; 2C-cut two times). Number of observation (*n*) for flowering plants 0C $n = 7$, 1C $n = 4$, 2C $n = 5$ and plants without flowering 0C $n = 4$, 1C $n = 6$, 2C $n = 5$. Significant differences ($P < 0.05$) according to the Tukey's *post hoc* test are indicated by different capital letters in treatment. Error bars represent standard errors of the mean.

three cuts, in comparison with one, two and five cuts, we recorded no significant effect of cutting frequency on the aboveground biomass production in 2010 or in 2011. We found differences in the aboveground biomass production between years. It seems that year-to-year variability in environmental conditions, especially precipitation, can significantly affect biomass production of *Rumex* species under different cutting frequencies.

Belowground biomass

Some differences in belowground biomass production between the studied species were recorded, but these differences were expressed under different cutting managements in different years. With the exception of flowering *R. obtusifolius*, all the studied species tended to produce more belowground than aboveground biomass.

The constant belowground biomass production of *R. obtusifolius* under all cutting frequencies was very interesting. This is in contrast with results reported by Hongo (1989) and by Stilmant *et al.* (2010), who recorded a reduction in belowground biomass under intensive defoliation. Different results can be explained by the use of more frequent cutting in the above-mentioned studies than in our study. A decrease in belowground biomass production of *R. obtusifolius* can probably be recorded if at least three cuts are applied per vegetation season. The constant belowground biomass production under increasing cutting frequencies was recorded only for *R. obtusifolius,* and it is probably connected to its high tolerance to intensive grassland management in comparison with the other *Rumex* species. A high tolerance of *R. obtusifolius* to different cutting frequencies was also recorded in the field experiment reported by Hopkins and Johnson (2002).

Rumex crispus and the *Rumex* OK-2 showed a significant decrease in belowground biomass with increasing cutting frequency in both years. *Rumex crispus* is well known for its poor regeneration after cutting and therefore for its low competitive ability in permanent grassland (Strnad *et al.*, 2012). The low tolerance of *R. crispus* to cutting management was consistent with the results of our study. It can be linked to a decreased energy investment into belowground organs after a loss of aboveground organs due to regular defoliation. Some authors (Hongo, 1988; Bond *et al.*, 2007) have proposed that *R. obtusifolius* invests more energy into belowground biomass than *R. crispus*. It seems that the higher investment of energy by *R. obtusifolius* into belowground organs, compared with that of *R. crispus*, may be valid only in regularly cut grasslands. The reverse situation can be recorded in unmanaged grasslands. As *Rumex* OK-2 produced substantially less belowground biomass under cutting management than under no cutting, it will probably suffer from the effects of intensive grassland management, similarly to *R. crispus*. *Rumex alpinus* has already been recorded to be sensitive to regular and frequent mowing under field conditions (Šťastná *et al.*, 2010). The decrease in *R. alpinus* belowground production under increasing

Table 4 Belowground/aboveground biomass ratio of flowering and non-flowering *Rumex obtusifolius* under different treatments in 2010 and 2011

Belowground/aboveground ratio	Treatment		
	No cut	One cut	Two cuts
Flowering	0.96 ± 0.24 b A ($n = 7$)	0.75 ± 0.21 b A ($n = 4$)	0.69 ± 0.20 b A ($n = 5$)
No flowering	3.15 ± 0.29 a A ($n = 4$)	2.61 ± 0.29 a AB ($n = 6$)	1.83 ± 0.21 a B ($n = 5$)

Numbers represent average, ± standard error of the mean (SE). Significant differences ($P < 0.05$) between treatments in each flowering category according to the Tukey's *post hoc* test are indicated by different capital letters in row and significant differences ($P < 0.05$) between treatments in each flowering category according to the Tukey's *post hoc* test are indicated by different small letters in column.

mowing frequencies in the first year indicates more negative effects of cutting management on *R. alpinus* than on *R. obtusifolius*. On the other hand, the decrease in belowground biomass of *R. alpinus* was not as strong and constant as in the case of *R. crispus*. Therefore, it seems that the sensitivity of *R. alpinus* to cutting management is probably lower than sensitivity of *R. crispus*. The decreased belowground biomass production of flowering *R. obtusifolius* might be the reason for reduction in *R. obtusifolius* under no or low management (Martinková & Honěk, 2001; Pavlů *et al*., 2008; Martinková *et al*., 2009; Hann *et al*., 2012).

Belowground/aboveground biomass ratio

Except for *R. obtusifolius* (0C, 1C) and *Rumex* OK-2 (0C), belowground and aboveground biomass showed a strong positive linear relationship. This was because *R. obtusifolius* was the only species that flowered in the seeding year and its plants invested energy into flower and seed production, rather than into belowground biomass. On the other hand, the strategy of *Rumex* OK-2 under no cut was to invest into belowground biomass regardless of the amount of aboveground biomass. This is probably preparation for successful flowering and seed production in subsequent vegetation seasons.

Conclusions

A higher cutting frequency can reduce belowground biomass of *Rumex* species, but no effect on the aboveground biomass was detected. The growing response of *Rumex* OK-2 to different cutting treatments was not very different from other studied *Rumex* species. The belowground biomass production of *Rumex* OK-2 was most similar to *R. crispus* under low cutting frequencies. These similarities indicate that the weed potential of *Rumex* OK-2 might correspond with that of *R. crispus*. As the results of 3 years of observations at the landscape level have revealed its fast expansion into surrounding grasslands in the area of its former planting, its high potential to become a new troublesome weedy species has already been confirmed (Hujerová *et al*., 2013). The results of the pot experiment can only be the first step to investigate the ecological requirements of a hybrid. Future investigations should be focused on the response of *Rumex* OK-2 to different mowing frequencies under competition from other plants under field conditions.

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