Competition Ability of Selected Amenity Varieties of *Festuca rubra* in Mixture with *Deschampsia caespitosa*

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Abstract

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The aim of the research was to evaluate the competition capacity and find suitable proportion of different types of *Festuca rubra* and *Deschampsia caespitosa* in grass mixtures for decorative lawns. A field experiment with *Deschampsia caespitosa* cv. Kometa in monoculture or in mixtures with *Festuca rubra* L. varieties Viktorka (ssp. *trichophylla*), Barborka (ssp. *commutata*) and Petruna (ssp. *rubra*) was established in Větrov in 2007. The sowing rate was 40 000 viable seeds per m^2 (0, 25, 50 or 75% of *F. rubra*). The sward was mown at 3 cm. The number and weight of tillers of the turf components were evaluated during three years. The highest number of tillers (on average 63.3 thousand/m^2) and weight of the dry aboveground phytomass (on average 196 g/m^2) were found with *F. rubra* ssp. *trichophylla*. Its particular tillers had the lowest dry weight (0.32 g/100 tillers). The lowest number of tillers (32.9 thousand/m^2) and low weight of dry aboveground phytomass (134 g/m^2) showed mixtures with *F. rubra* ssp. *rubra,* whose tiller weight was relatively high (0.42 g/100 tillers)**.** The size of *F. rubra* tillers was not influenced either by the mixture composition or by vegetation years. The number of *F. rubra* tillers was not significantly different in the third and first vegetation year. The number of *D. caespitosa* tillers in monoculture decreased during the years from 45 to 30 thousand/m^2, but the weight of dry aboveground phytomass increased significantly from 233 g/m^2 to 318 g/m^2. Poor competition of *D. caespitosa* was found in the mixture with *F. rubra* ssp. *commutata* (on average 4% of total number of tillers and 7% of the total weight of the dry aboveground phytomass). *F. rubra* ssp. *trichophylla* was less competitive and the least competition with *D. caespitosa* was found in *F. rubra* ssp. *rubra,* After three years the proportion of *D. caespitosa* in mixtures with *F. rubra* ssp. *rubra* significantly increased to 36% of the total number of tillers and to 55% of the total weight of phytomass. Mixtures of *D. caespitosa* and *F. rubra* ssp. *rubra* were found to be promising for low input lawns.

Keywords: competition; cultivars; lawn density; red fescue; tufted hairgrass; turfgrass

In the past 20 years, breeding of grasses has focused on new goals worldwide, as well as in the Czech Republic, such as non-productive purposes, sport fields, and ornamental or recreational lawns. According to the changing climate conditions (warming up, temperature fluctuation, incidence of extreme conditions, etc.), with respect to increasing necessity of diminished water consumption, emphasis has been placed on selecting species and cultivars for quality turf establishment in cities and countryside. The aims for breeding of the traditional species are also changing. Besides intensive lawns, great attention is paid to "low-input lawns". In the Czech Republic, new species have been included into breeding programmes, such as *Koeleria macrantha*, *Poa compressa*, *Holcus lanatus*, *Phleum bulbosum* or *Deschampsia caespitosa.* The last one mentioned, *Deschampsia caespitosa* L. Beauv., is an extremely variable species with a high physiological plasticity, especially high tolerance to different soil and water conditions and ability of acclimation to different temperature regimes and solar radiation (Davy & Taylor 1974). It is also recommended for utilisation in wet and in shady areas because of its tolerance to low solar radiation (Brilman & Watkins 2003). *D. caespitosa* can be used in parks, recreational lawns with high wear intensity, in areas with reduced fertility or sunlight (Pronczuk & Pronczuk 2005), and for countryside lawns with low-input management. Meta was the first variety developed in 1981 in our country (Plant Breeding Station Větrov). The problem with non-traditional species is that there is not much information and practical experience regarding their development and competition in mixtures with other grasses under relatively frequent mowing, corresponding with common management of park lawns. *D. caespitosa* is generally studied as a wild component of pastures, meadows or other natural swards under a range of ecological conditions (water, soil and temperature regimes). There are also some problems with *D. caespitosa* during the sward establishment and development because of its slow initial development and susceptibility to drought during emergence.

Festuca rubra L. is one of possible components in lawn mixtures with *D. caespitosa*. There are hundreds of amenity varieties of bunch type and rhizomatous subspecies of this species. Their competitive capacities are different and vary during their development. In some commercial mixtures and under specific conditions and management, *D. caespitosa* is suppressed too much and, subsequently, its separated bunches result in poor performance of the lawn.

The aim of this research was to evaluate the development of different types of *Festuca rubra* (bunch type, strong and slender creeping) in the mixture with the Czech variety of *Deschampsia caespitosa* Kometa and to find a suitable proportion of both components in grass mixtures for decorative lawns.

MATERIAL AND METHODS

A field experiment was established on 18th April 2007 at the Oseva Uni Choceň, a.s., Plant Breeding Station Větrov (620 m a.s.l., average year temperature 6.9°C, average annual precipitation 642 mm, soil group: loamy-sand soil, brown, podzolic and moderately acid soil). The Czech variety of *Deschampsia caespitosa* Kometa, was sown in monoculture or in two-component mixtures with the Czech *Festuca rubra* amenity varieties of Viktorka (ssp. *trichophylla*), Barborka (ssp. *commutata*) and Petruna (ssp. *rubra*). The sowing rate in the monoculture and mixtures was always 40 000 viable seeds/m^2. The proportion of *F. rubra* in the mixtures was 25, 50 or 75% of the total number of viable seeds. The broadcast sown seed was shallowly (1 cm) incorporated into soil by rakes, then rolled, covered with a white synthetic geotextile and irrigated during the time of emergence. Later on, no irrigation was applied. Each variant had four replications and a randomized block design was used. The plot size was 2 m^2. One half of the plot was used for lawn performance evaluation and the second one for sampling.

The sward was mowed every 7 to 9 days. The mowing height was 3 cm. The last mowing was made in the middle of October. The weed and pest management was conducted according to the sward fitness with Bofix (clopyralid 20 g/l, fluroxypyr 40 g/l, MCPA 200 g/l). The sward was fertilized once per month alternating between combined granulated fertilizer Rasen Floranid (NPKMg 20–5–8–2) and calcium nitrate at a total rate of 120 kg N/ha per year.

As shown in Table 1, the first year of vegetation was extraordinarily warm in comparison with the long term average temperature (especially the first half of the year). The second vegetation year was very warm and the third was warm. The amount of precipitation during the first year was normal (except extraordinarily dry April). The second year was very dry and the third year can be classified as a normal one. The classification was carried out according to Kožnarová and Klabzuba (2002).

The number and weight of tillers of all turf components were evaluated during three years. The samples (three from each plot; in total twelve cores per variant) were taken with Kopecky rings

Table 1. Total precipitation and average temperature during the experiment and long term average (1961–1990)

Month	Total precipitation (mm)				Average temperature (°C)			
	average	2007	2008	2009	average	2007	2008	2009
1	33.9		32.4	9.3	–3.3		0.4	–4.7
2	34.0		20.2	45.7	–1.7		1.9	–2.2
3	38.5		56.8	67.3	1.9		2.2	2.1
4	49.4	5.1	39.5	45.4	6.5	10.7	7.2	12.2
5	77.0	71.4	44.7	101.0	11.4	13.6	13.3	12.6
6	86.8	62.8	51.0	71.8	14.5	17.3	16.4	13.7
7	81.5	96.0	63.1	112.6	16.2	17.5	17.1	16.6
8	75.5	83.2	69.8	38.8	15.9	16.9	16.9	18.3
9	51.7	116.4	21.7		12.4	10.6	11.4	
10	41.7	32.1	26.8		7.4	6.7	7.8	
11	42.6	48.2	38.2		1.8	0.3	3.6	
12	36.0	23.0	28.7		–1.6	–1.7	–0.5	

(50 mm diameter) three to four times per year (ten samplings in total), always up to four days after mowing. The aboveground phytomass was cut off from the rest and the tillers of the particular grass species were separated from one another. Then the number of tillers/m^2 was determined for each species. All aboveground phytomass was dried for 24 h at 105°C. Afterwards, the dry matter (DM) weight was determined.

The data were processed by multifactorial analyses of variance (LSD, $P \leq 0.05$) using the Statgraphics programme, version XV (StatPoint, Inc., Herndon, Virginia, USA).

RESULTS AND DISCUSSION

For evaluation of the *F. rubra* competition influence in the sward, detailed knowledge of the other component development in monoculture, in this case *D. caespitosa* (Table 2), was important. In the second vegetation year (2008), the average number of tillers of *D. caespitosa* in monoculture decreased by 30% in comparison with the first year (to 32 thousand/m^2). In 2009 the number of tillers was 30 thousand/m^2 on average, which means a decrease by 33% in comparison with the first year. However, the total dry weight of the *D. caespitosa* aboveground phytomass had increased significantly from 233 to 318 g/m^2 as a result of the increasing tiller size (weight). The weight of 100 tillers increased from 0.518 g (2007) to 1.071 g (2009).

The effects of the *F. rubra* variety and *D. caespitosa* proportions in the sward and the vegetation year on different lawn characteristics are clear from Table 3. Because an elucidation of the effects of the three *F. rubra* subspecies on the development of the lawn was the most important aim of

Table 2. Number of tillers/m^2, aboveground dry matter weight and weight of 100 tillers in monoculture of *Deschampsia caespitosa* in different years

	No. of tillers/m^2	Dry weight of aboveground phytomass (g/m^2)	Weight of 100 tillers (g)
Average	35 871	281	0.833
2007	45 463^b	233^a	0.518^a
2008	31 889^a	291^b	0.910^b
2009	30 262^a	318^b	1.071^b

Means in columns followed by the same letter are not significantly different from each other (LSD test, $P < 0.05$)

Table 3. Number of tillers/m^2, aboveground dry matter weight and dry weight of 100 tillers for *D. caespitosa* (Dc), *F. rubra* (Fr), *F. r. commutata* (Frc), *F. r. trichophylla* (Frt) and *F.r. rubra* (Frr), and proportion of Dc-tillers and aboveground dry phytomass in the sward

		No. and proportion (%) of tillers/m^2				Dry weight (g/m^2) and proportion (%) of aboveground phytomass				Dry weight of 100 tillers (g)	
		Dc	Fr	total	%Dc	Dc	Fr	total	%Dc	Dc	Fr
F. rubra ssp. in seed mixture	Frc	2317^{a}	56 559^{b}	58 876^{b}	3.9^{a}	14^{a}	189^{b}	203^{a}	6.9^{a}	0.54^{a}	0.36^{a}
	Frt	5351^{b}	63 302^{c}	68 653^{c}	7.8^{a}	36^{b}	196^{b}	233^{b}	15.6^{b}	0.61^{ab}	0.32^{a}
	Frr	8123^{c}	32 941^{a}	41 064^{a}	19.8^{b}	61^{c}	134^{a}	194^{a}	31.1^{c}	0.68^{b}	0.42^{b}
Dc proportion in seed mixture (%)	25	1931^{a}	58 690^{c}	60 621^{b}	3.2^{a}	14^{a}	190^{b}	205^{a}	7.0^{a}	0.61^{a}	0.34^{a}
	50	5243^{b}	50 371^{b}	55 613^{a}	9.4^{b}	36^{b}	176^{b}	213^{a}	17.0^{b}	0.58^{a}	0.38^{a}
	75	8618^{c}	43 742^{a}	52 359^{a}	16.5^{c}	60^{c}	152^{a}	212^{a}	28.4^{c}	0.63^{a}	0.38^{a}
Year	2007	4499^{a}	48 451^{a}	52 951^{a}	8.5^{a}	18^{a}	181^{a}	199^{a}	9.1^{a}	0.38^{a}	0.39^{b}
	2008	2812^{a}	59 910^{b}	62 722^{b}	4.5^{a}	17^{a}	185^{a}	202^{a}	8.6^{a}	0.59^{b}	0.32^{a}
	2009	8480^{b}	44 441^{a}	52 921^{a}	16.0^{b}	75^{b}	153^{a}	228^{b}	33.0^{b}	0.85^{c}	0.38^{b}

Means in columns followed by the same letter are not significantly different from each other (LSD test, $P < 0.05$)

the experiment, the detailed data for individual *F. rubra* varieties are presented in Table 4.

Red fescues used for the experiment were of different subspecies, and differed in the size of tillers. The highest dry matter weight of 100 tillers was obtained with *F. rubra* ssp. *rubra* (0.42 g on average). The tiller dry weights of *F. rubra* ssp. *commutata* and *F. rubra* ssp. *trichophylla* tillers were 0.36 and 0.32 g respectively. The tiller size of *F. rubra* varieties was not influenced markedly by its proportion in the seed mixture, it neither increased nor decreased, unlike *D. caespitosa*, during the years under observation.

The average number of *F. rubra* tillers and the dry weight of its phytomass were significantly influenced by the *F. rubra* proportion in the sown mixture. The highest density of *F. rubra* tillers was found with the *F. rubra* ssp. *trichophylla* variety Viktorka (63.3 thousand/m^2 on average). Despite the low weight of 100 tillers of this *F. rubra* ssp., it had produced significantly more aboveground phytomass (196 g/m^2 on average) than *F. rubra* ssp. *rubra* (134 g/m^2). *F. rubra* ssp. *rubra* produced significantly lower number of tillers per m^2 (32.9 thousand) than *F. rubra* ssp. *commutata* (56.6 thousand) and *F. rubra* ssp. *trichophylla* (63.3 thousand). The numbers of tillers in all the *F. rubra* varieties in the third year were comparable (not statistically different) with that in the first vegetation year. The number of tillers of all *F. rubra* varieties was mostly positively related to the *F. rubra* proportion in the seed mixture, but the interspecies competition effects were also evident. Competition between morphologically similar species (in this case two grass species) is probably determined, above all, by their ability to occupy the space by fast production of phytomass (Begon *et al.* 1999), regardless of the tillers number. The average total weight of the aboveground phytomass was highest in the mixtures with *F. rubra* ssp. *trichophylla* (233 g/m^2) and it was significantly higher in the third vegetation year (228 g/m^2) than in the first vegetation year (199 g/m^2) in spite of the same total number of tillers. This was evidently due to the significant increase of the weight of individual *D. caespitosa* tillers from the first to the third vegetation year (from 0.38 g/100 tillers to 0.85 g/100 tillers; on average by 132% in mixtures as opposed to 105% in monoculture). As shown in the tables the weight of 100 tillers of *D. caespitosa* was higher in the monoculture than in the mixtures, from the first vegetation year.

The average proportion of *D. caespitosa* tillers or its aboveground phytomass weight in the sward was highest in the mixtures with *F. rubra* ssp. *rubra*, at its high proportion in the sown mixture and in the third vegetation year.

Considering the influence of *F. rubra* proportion in seed mixtures, the total weight of the dry aboveground phytomass was similar (insignificant differences) in all mixtures with different *D. caespitosa* proportions (Table 4), but on average it was lower by 25% in comparison with the *D. caespitosa* monoculture (Table 2) (by 28% in mixtures with *F. rubra* ssp. *commutata*, by 17% with *F. rubra* ssp. *trichophylla* and by 31% with *F. rubra* ssp. *rubra* (original data in Tables 3 and 4). This demonstrates that the mixed swards of *D. caespitosa* and *F. rubra* did not reach the maximum in the aboveground space.

It is obvious from the data presented in Tables 3 and 4 that *D. caespitosa* showed the least competition in combination with *F. rubra* ssp. *commutata*. With only 25% of *D. caespitosa* in the sown seed mixture, *D. caespitosa* was totally suppressed by *F. rubra* ssp. *commutata* already in the second vegetation year (Table 4). In the swards established with higher proportion of *D. caespitosa* in the seed mixture it had contributed, at the maximum, 6.4% of the total number of tillers and 10.2% of the total weight of the aboveground phytomass (5.7% and 13.3% on average in the third vegetation year). The number of *F. rubra* ssp. *commutata* tillers (51–65 thousand/m^2) was significantly influenced by its proportion in the seed mixture. It was lower on average by 20% when the proportion of *D. caespitosa* was 50 or 75% in the seed mixture. The advantage of *F. rubra* ssp. *commutata* could, according to our greenhouse experiments, lie in its quicker emergence in comparison with *D. caespitosa* (unpublished data) and nearly two times quicker leaf growth after emergence in comparison with *D. caespitosa* (Svobodová *et al.* 2010). In spite of a high tiller number of *F. rubra* ssp. *commutata* in particular seed mixtures during the years, it is not possible to assert that this factor (the number of tillers) was the reason for such a strong suppression of *D. caespitosa* which succeeded better in the mixtures with *F. rubra* ssp. *trichophylla* that produced even more tillers than Barborka (Tables 3 and 4). It is more likely that the competition capacity of *F. rubra* ssp. *commutata* was based on a strong competition in the root zone, as also indicated in our greenhouse experiments (Svobodová *et al.* 2010). Other variety (Veverka) of *F. rubra* ssp. *commutata* in the experiment of Straková and Hrabě (2001) also showed the weight of the root phytomass in the monoculture higher by 19–28% than in *D. caespitosa* cv. Kometa during the four vegetation years.

F. rubra ssp. *trichophylla*, in comparison with *F. rubra commutata*, was a weaker competitor in spite of its significantly highest number of tillers and its highest weight of the aboveground phytomass (Table 3). *F. rubra* ssp. *trichophylla* was able to produce such a high amount of phytomass in spite of the fact, that its tillers were smaller (0.32 g/100 tillers on average) than those of *F. rubra* ssp. *commutata* (not significant). *D. caespitosa* established best with this *F. rubra* subspecies in the variant where it made up 75% of the sown mixture. In this case the proportion of *D. caespitosa* in the sward was 14% of the total number of tillers and 28% of the weight of the total aboveground phytomass. The better competition of *D. caespitosa* in the mixture with *F. rubra* ssp. *trichophylla* could have also been due to a slower development of the root system in *F. rubra* ssp. *trichophylla* compared with *F. rubra* ssp. *commutata* (Svobodová *et al.* 2010).

Among the three tested cultivars, the weakest competitor and thus the most suitable component in the mixture with *D. caespitosa* was the strong-creeping cultivar *F. rubra* ssp. *rubra* (Table 4). Over the years, an increase in the number of *D. caespitosa* tillers and its dry aboveground phytomass weight was noticed. After three years, the proportion of *D. caespitosa* tillers in the sward increased significantly from 14 to 36% of the total number of tillers and from 14 to 55% of the total aboveground phytomass. In the third vegetation year, the weight of 100 *D. caespitosa* tillers was 0.90 g. Correspondingly, the weight of 100 tillers of *F. rubra* ssp. *rubra* was 0.43 g, which was on average 34% more compared with the other cultivars of *F. rubra*. A lower competition pressure of *F. rubra* ssp. *rubra* to *D. caespitosa* Kometa in initial stages of development was also found in greenhouse experiments (Svobodová *et al*. 2010), where the number of *D. caespitosa* tillers after three months of growth was about 2.5 times higher in comparison with *F. rubra* ssp. *rubra.*

In conclusion, it was confirmed, that the bunch type form of *F. rubra* is too strong a competitor for *D. caespitosa*. Both creeping types (slender and strong) enabled a satisfactory development

Table 4. Number of tillers/m^2, aboveground dry matter weight and dry weight of 100 tillers for *D. caespitosa* (Dc), *F. rubra* ssp. *commutata* Barborka (Frc), *F. rubra* ssp. *trichophylla* Viktorka (Frt), *F. rubra* ssp. *rubra* Petruna (Frr), and % Dc in different seed mixtures and vegetation years

		No. of tillers/m^2				Dry weight of aboveground phytomass (g/m^2)				Dry weight of 100 tillers (g)	
		Dc	Frc	total	%Dc	Dc	Frc	total	%Dc	Dc	Frc
Dc proportion in sowing rate (%)	25	428^{a}	65 295^{b}	65 724^{b}	0.7^{a}	2^{a}	194^{a}	196^{a}	1.0^{a}	0.55^{a}	0.30^{a}
	50	3529^{a}	51 495^{a}	55 024^{a}	6.4^{a}	22^{a}	187^{a}	210^{a}	10.5^{a}	0.48^{a}	0.41^{b}
	75	2993^{a}	52 887^{a}	55 881^{a}	5.4^{a}	18^{a}	184^{a}	202^{a}	8.9^{a}	0.59^{a}	0.36^{ab}
Year	2007	2458^{a}	53 352^{a}	55 810^{a}	4.4^{a}	8^{a}	194^{a}	203^{a}	3.9^{a}	0.36^{a}	0.37^{a}
	2008	1200^{a}	61 832^{a}	63 032^{a}	1.9^{a}	6^{a}	188^{a}	195^{a}	3.1^{a}	0.48^{a}	0.31^{a}
	2009	3293^{a}	54 494^{a}	57 787^{a}	5.7^{a}	28^{a}	183^{a}	210^{a}	13.3^{a}	0.79^{b}	0.39^{a}
			Frt				Frt				Frt
Dc proportion in sowing rate (%)	25	1588^{a}	73 057^{b}	74 645^{b}	2.1^{a}	12^{a}	225^{c}	237^{a}	5.1^{a}	0.59^{a}	0.32^{a}
	50	5294^{ab}	62 054^{a}	67 348^{ab}	7.9^{ab}	33^{ab}	196^{b}	229^{a}	14.4^{a}	0.61^{a}	0.32^{a}
	75	9172^{b}	54 796^{a}	63 968^{a}	14.3^{b}	64^{b}	168^{a}	232^{a}	27.6^{b}	0.63^{a}	0.31^{a}
Year	2007	5294^{ab}	57 282^{a}	62 576^{a}	8.5^{ab}	21^{a}	196^{ab}	217^{a}	9.7^{a}	0.37^{a}	0.34^{a}
	2008	2527^{a}	78 357^{b}	80 884^{b}	3.1^{a}	14^{a}	221^{b}	235^{ab}	6.0^{a}	0.58^{a}	0.28^{a}
	2009	8233^{b}	54 267^{a}	62 500^{a}	13.2^{b}	73^{b}	173^{a}	246^{b}	29.7^{b}	0.87^{b}	0.32^{a}
			Frr				Frr				Frr
Dc proportion in sowing rate (%)	25	3778^{a}	37 716^{b}	41 494^{a}	9.1^{a}	30^{a}	152^{b}	182^{a}	16.5^{a}	0.69^{a}	0.40^{a}
	50	6905^{a}	37 563^{b}	44 468^{a}	15.5^{a}	54^{a}	145^{b}	199^{a}	27.1^{a}	0.68^{a}	0.42^{a}
	75	13 687^{b}	23 543^{a}	37 230^{a}	36.8^{b}	99^{b}	104^{a}	203^{a}	48.8^{b}	0.67^{a}	0.45^{a}
Year	2007	5747^{a}	34 720^{ab}	40 467^{a}	14.2^{a}	25^{a}	154^{b}	179^{a}	14.0^{a}	0.41^{a}	0.46^{a}
	2008	4710^{a}	39 540^{b}	44 250^{a}	10.6^{a}	32^{a}	145^{b}	177^{a}	18.1^{a}	0.71^{b}	0.38^{a}
	2009	13 914^{b}	24 562^{a}	38 476^{a}	36.2^{b}	125^{b}	103^{a}	227^{b}	55.1^{b}	0.90^{b}	0.43^{a}

Means in columns followed by the same letter are not significantly different from each other (LSD test, $P < 0.05$)

of *D. caespitosa* when sown at the ratio of 25% *F. rubra* and 75% *D. caespitosa* (total sowing rate 180 kg/ha). Lawns established with the strong creeping *F. rubra* ssp. *rubra* had, on average, a lower density (30% less tillers than the mixture with *F. rubra* ssp. *commutata*), but enabled an acceptable proportion of *D. caespitosa* tillers, which was increasing over the three years. Overall, the lawn appearance, its texture and homogeneity, corresponded with the requirements for the common park lawns when mowed to 3 cm. This turfgrass mixture is suitable for the so called low-input park lawns including slightly shaded areas, and for extensive countryside lawns.

Most of the amenity varieties of *F. rubra* in the world assortment belong to *trichophylla* or *commutata* ssp. But our results indicated that the strong creeping subspecies *F. rubra* ssp. *rubra* could be perspective for low input lawns purposes.

These experiments also showed that not only the number of tillers plays an important role in competition for the aboveground space, but also the weight of tillers of individual species. Both properties can change significantly over time. For successful utilization of *D. caespitosa* in mixture with *F. rubra* it is important not only to choose an appropriate sowing rate, but also to select suitable cultivars of *F. rubra.*

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