SPECIES DIVERSITY AND YIELDS OF FOXTAIL STAND TYPE (*ALOPECURETUM*) AT DIFFERENT FERTILIZATION

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Foxtail stand type (*Alopecuretum*) represents a plant community with certain dominant species which are prevailingly growing on mesophyte to mesohygrophyte sites in all production regions. The study has been aimed at evaluating of the changes in dominance of different agrobotanical groups and species in the years 1995 to 1996. The investigations were carried out in original stand, at fertilization P_{40} K_{100} and N_{200} (+PK). High total representation was recorded in fertilized variant N_{200} P_{40} K_{100}, in original stand 10% decrease and in area with application P_{40} K_{100} 18% decrease of this representation appeared in the last years of investigations. The greatest representation of grass component was in the N fertilized variant (94 %) where legumes were reduced and other dicotyledonous species decreased. The highest percentage of dominance of *Alopecurus pratensis* was recorded when N was applied. Dominance from 78% to 59% was falling gradually in the years of investigations and other dicotyledonous stoloniferous grasses were spread. Yielding capacity of *Alopecureta* is variable and affected by trophosery and hygrosery of the site. In original stand the stands of dry fodder ranged from 10.82 $t.ha^{-1}$ (1967) to 2.81 $t.ha^{-1}$ (1983). Average yield of dry fodder in the control variant over 30 years amounted to 5.21 $t.ha^{-1}$. Increase of the yield of dry fodder compared with the control was recorded at PK-fertilization alone, that is by 7.6%, i.e. by 5.6 $t.ha^{-1}$. Annual nitrogen fertilization at the rate 200 kg $N.ha^{-1}$ (+PK) had significant influence on the production of above-ground biomass. The highest yield (15.98 $t.ha^{-1}$) was found in 1967, on the contrary the low yield was in the dry year 1989, i.e. 4.25 $t.ha^{-1}$. Nitrogen fertilized variant was more yielding by 67 % in 30-year investigation compared with the control. Variants fertilized only with PK do not show statistically significant difference compared with the control areas and variants with application of 200 kg $N.ha^{-1}$ (+PK) are statistically significantly different from unfertilized ones on both levels of significance.

foxtail stand type; dominance; yields

INTRODUCTION

Natural grasslands are floristically very differentiated plant communities. Their production capacity, nutritive and dietetic value depend above all on species composition of the stand. Different plant species are quantitatively and qualitatively significantly different.

Stand type as a phytocenological category represents plant community with certain dominant species (edificators) which are accommodating to ecological conditions of the site, subsequently affect the yields and quality of fodder (Klečka et al., 1938). Different meadow types are distinguished from each other not only by quality, real and potential yielding capacity, but also in view of their non-production functions in the region (Rychnovská, 1985). Foxtail meadows (*Alopecurus*) represent one of the most yielding stand types. As reported by Regal, Veselá (1975), Klimeš (1997), Holúbek et al. (1997), they are represented by 10% of cenosis of the total area of permanent grasslands. These are three-cut meadows, only in higher altitudes with shorter vegetation season they give two cuts.

In practical meadow management foxtail meadows are classified into higher degree of intensity of management. Klečka et al. (1938), Regal, Veselá (1997), Jančovič (1997) etc. consider *Alopecureta* as mesophyte to mesohygrophyte stands. They are distributed in all production regions and exceptionally they appear also in subalpine zone. They have optimal conditions in floodplain and alluvial soils. Klečka et al. (1938) report that main factors deciding on dominance and viability of meadow foxtail (*Alopecurus pratensis*) are moisture and nitrogen. According to Tomka (1974), Regal, Veselá (1975), Velich, Štráfelda (1975) freely tussocky grasses represented in *Alopecureta* loss the viability, species reduction appear and gradually rhizomatous grasses are distributed.

Yielding capacity of foxtail meadows are very diverse (Krajčovič et al., 1968; Krajčovič, Regal, 1976; Regal, Veselá, 1975 etc.). Under optimal moisture conditions and good reserve of nutrients in soil 10 tons and more of hay per 1 ha can be obtained.

MATERIAL AND METHODS

The trial with long-term study of botanical composition of the stand and yielding capacity was founded in 1966 in Černíkovice, Benešov region, on very fertile floodplain meadow of mesophyte to mesohygrophyte character. The locality is situated at 363 m above sea level, with average sum of precipitation 617 mm and average annual temperature 7.8 °C. Underground water ranges from 0.1 to 0.7 m under the soil surface. The great soil group – gleyic, soil texture (0–0.2 m) – loam, pH (KCl) – 5.0, % Cox = 2.90%, N_t = 0.41, C_t/N_t = 7.07.

The trial was established by the method of randomised blocks in four replications. The area of experimental plots was 30 m^2 (5 m x 6 m). The following variants of fertilization were chosen for evaluation: 0 – P_{40} K_{100} – N_{200} P_{40} K_{100}. The basic form of fertilizer was ammonium nitrate with limestone (LAV 27.5), the rate 200 kg N.ha^{-1} was split in the ratio 3:1 in spring and after first cut. Phosphorus (40 kg.ha^{-1}) was supplied in the form of superphosphate in autumn and potassium (100 kg.ha^{-1}) in potassium salt was applied in autumn and from 1985 after the first cut (Velich, Mrkvička, 1988).

Floristic composition of phytocenosis was evaluated always close before the harvest of the first cut when aspect of the stand (grasses in growth phase of heading) allowed to distinguish well different species. The method of estimate of reduced projective representation (dominance D) expressing surface share (in %) which covers different agrobotanical groups and species on the level of height of cut, i.e. about 50 mm above soil surface. The total area = 100% = % D + % of blank places. To reduce inaccuracy of estimates the method of gradual division of the total dominance into morphologically different agrobotanical groups and into different species. Expression of species composition of phytocenosis of permanent grasslands in % of projective reduced dominance became fully prevailing method in the studies on meadow management in CR and abroad.

RESULTS AND DISCUSSION

In original foxtail stand except *Alopecurus pratensis* the following species were represented: *Poa pratensis* (11%), *Festuca pratensis* (10%), *Holcus lanatus* (7%). The total representation of legumes (mainly *Trifolium hybridum*) was 11%. Of other dicotyledonous species (16%) the greatest representation was recorded in *Ranunculus repens* (8%). Average representation of agrobotanical groups in five-year cycles from 1966 to 1990 is given in Table I from which increase of representation of grasses follows under nitrogen nutrition. Rhizomatous *Alopecurus pratensis* (87–59%) was the most spread when its representation has been reduced in all variants since 1981. On the contrary, on the control and N-fertilized variant representation of other rhizomatous grasses was increasing, e.g. *Poa trivialis*, less *Poa pratensis* (from 5 to 35%) and the species (+) *Agrostis stolonifera*, *Festuca rubra* and *Elytria repens* occurred rarely (Table II).

Regal, Veselá (1981) consider as the most significant components in *Alopecurus* with high presence (P) of *Elytrigia repens* (P = 46%), *Poa*

I. Total representation, % of dominance of grasses, legumes and other dicotyledonous herbs in *Alopecuretum* in the years 1966 to 1990, Černíkovice

Variant	Period of years	Total representation in %	% of dominance		
			grasses	legumes	other herbs
Control	1966–1970	97.5	62.5	8.8	26.2
	1971–1975	96.0	59.0	4.4	32.6
	1976–1980	81.9	66.6	1.0	14.3
	1981–1985	83.3	68.3	4.0	11.0
	1986–1990	90.0	69.2	5.8	15.0
	1990–1995	87.5	65.0	9.0	13.5
	average	89.4	65.1	5.5	18.8
P_{40} K_{100}	1966–1970	98.3	67.5	12.0	18.8
	1971–1975	91.0	65.0	7.6	18.4
	1976–1980	86.6	58.3	14.3	14.0
	1981–1985	84.9	53.3	18.3	13.3
	1986–1990	80.0	48.0	17.0	15.0
	1990–1995	80.0	47.5	15.0	17.5
	average	86.8	56.6	14.0	16.2
N_{200} P_{40} K_{100}	1966–1970	99.0	90.5	+	8.5
	1971–1975	99.0	95.0	+	4.0
	1976–1980	99.5	98.0	–	1.5
	1981–1985	99.0	96.0	–	3.0
	1986–1990	97.0	95.0	–	2.0
	1990–1995	95.0	92.0	–	3.0
	average	98.08	94.42	–	3.66

trivialis (P = 51%), *Ranunculus repens* (P = 44%), *Deschampsia caespitosa* (P = 54%), *Festuca rubra*, *Festuca pratensis* (P = 49%) and *Alchemilla* sp. (P = 39%). Similar composition of accompanying species to *Alopecurus pratensis* is described by Krajčovič et al. (1968). According to the underground water and length of inundation he gives except the mentioned grass species: *Agrostis stolonifera*, *Poa palustris* and *Phleum pratense*. He also mentions distribution of undesired species which can be removed by pratotechnics.

II. Average dominance of grasses in *Alopecuretum* in the years 1966 to 1990, Černíkovice

Variant	Period of years	% of dominance			
		rhizomatous grasses		freely tussock grasses	
		meadow foxtail	others	cultural	non-cultural
Control	1966–1970	33.0	10.0	10.0	9.5
	1971–1975	35.0	11.0	3.0	10.0
	1976–1980	36.0	5.6	6.0	19.0
	1981–1985	25.0	9.0	8.3	26.0
	1986–1990	20.2	14.0	12.0	23.0
	1990–1995	13.0	16.0	13.0	23.0
P_{40} K_{100}	1966–1970	36.0	11.0	10.0	10.5
	1971–1975	27.0	10.0	3.0	25.0
	1976–1980	30.0	5.3	10.0	13.0
	1981–1985	18.3	7.0	10.0	18.0
	1986–1990	14.0	5.0	12.0	17.0
	1990–1995	13.0	5.5	10.0	19.0
N_{200} P_{40} K_{100}	1966–1970	78.0	5.0	5.5	2.0
	1971–1975	86.5	6.0	2.0	1.0
	1976–1980	87.0	10.0	1.0	+
	1981–1985	64.0	28.0	2.0	2.0
	1986–1990	65.0	30.0	+	+
	1990–1995	59.0	35.0	+	+

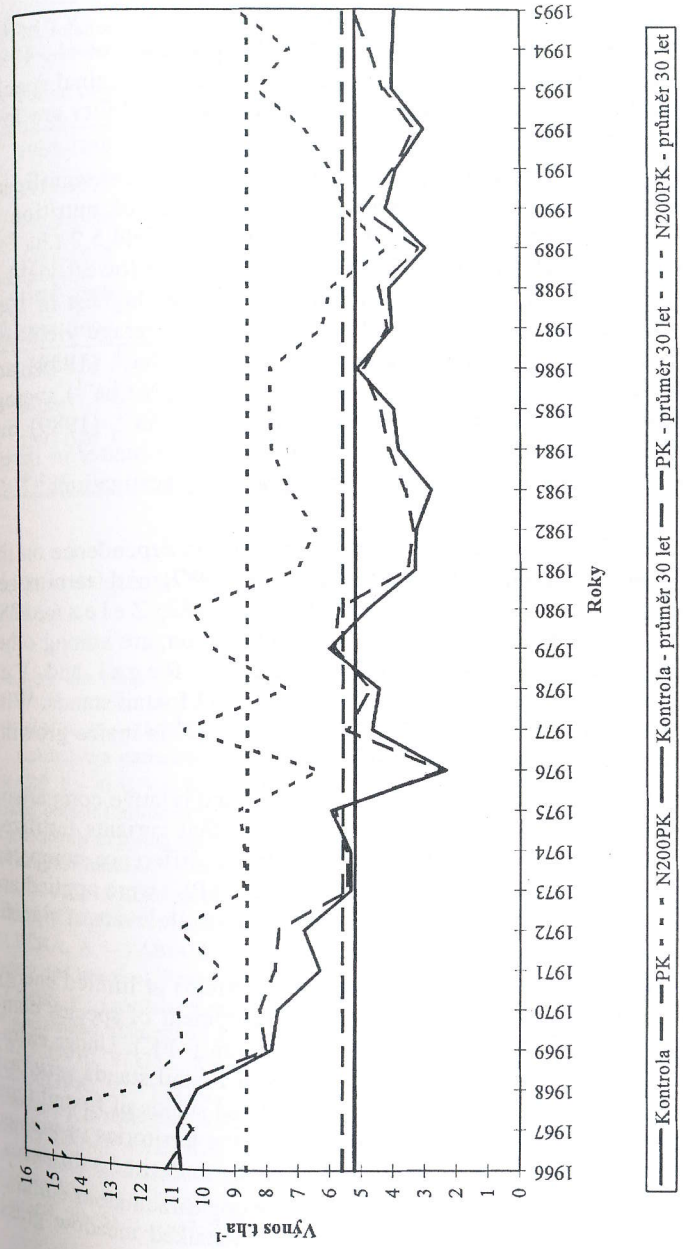
Dominance of legumes in the control variant varies from 1 to 9% (*Trifolium hybridum*, *Trifolium repens*, *Trifolium pratense*) and since 1990 distribution of *Lathyrus pratensis* (D = 5%) and *Trifolium dubium* (D = 2–3%) has been occurred. In wide range representation of dicotyledonous species varies (11–33%), where they are distributed in some years: *Ranunculus repens* (1–30%), *Taraxacum officinale* (2–14%), *Ranunculus acer* (1–7%) and *Rumex acetosa* (1–2%). Another 16 dicotyledonous species had rare occurrence (+). Of freely tussock grasses non-cultural species from original dominance are distributed D = 10–23% (*Holcus lanatus* 7–35% and *Anthoantum odoratum* 2–5%). *Festuca pratensis* dominated of cultural, freely tussock grasses in the stand.

III. Yields of dry fodder (t.ha^{-1}) at different level of fertilization in the years 1966 to 1995, Černíkovice

Years	Control	PK	N_{200} PK	Years	Control	PK	N_{200} PK
1966	10.71	11.23	14.58	1981	3.32	3.56	7.06
1967	10.82	10.33	15.98	1982	3.28	3.36	6.47
1968	10.20	11.19	12.04	1983	2.81	3.63	7.30
1969	7.84	8.01	10.62	1984	3.85	4.14	7.86
1970	7.65	8.23	10.83	1985	4.00	4.42	7.93
Average	9.44	9.80	12.81	Average	3.45	3.82	7.32
1971	6.32	7.74	9.44	1986	5.16	4.99	7.90
1972	6.83	7.62	10.75	1987	4.04	4.18	6.29
1973	5.34	5.46	8.75	1988	4.14	4.46	6.00
1974	5.36	5.47	8.71	1989	3.00	3.25	4.25
1975	5.97	5.85	8.87	1990	4.25	4.99	5.55
Average	5.96	6.43	9.30	Average	4.12	4.37	6.00
1976	2.35	2.53	6.40	1991	3.93	4.00	5.99
1977	4.67	5.48	10.61	1992	3.06	3.33	6.83
1978	4.45	4.71	7.43	1993	4.05	4.31	8.28
1979	6.04	5.88	9.65	1994	4.02	4.76	7.31
1980	4.81	5.74	10.40	1995	3.95	5.28	8.92
Average	4.46	4.87	8.90	Average	3.80	4.34	7.47

In the variant fertilized with P_{40} K_{100} representation of legumes (8–18%) is more stable and the other dicotyledonous herbs (13–19%).

Species diversity was markedly reduced at nitrogen fertilization (N_{200} P_{40} K_{100}), when of total representation (65–99%) rhizomatous grasses (91–98%) were dominant and representation of dicotyledonous species fell. Legumes completely disappeared over the years. It is evident from the results of Velich, Štráfelda (1975) that rhizomatous grasses with respect to greater capacity of reserve organs and to greater residual leaf area after cutting and bigger ability of vegetative propagation are better adapted to use also higher rates of available N than less hardy, full-grown freely tussock grasses. Distribution of rhizomatous grasses at increased N fertilization is reported by Tomka (1974). He points out to distribution of not only full-grown rhizomatous grasses, but representation increases even in low rhizomatous grasses.



1. Yields of dry fodder (in t.ha^{-1}) at different level of fertilization in the years 1966 to 1995, Černíkovice

Roky = years, Výnos t.ha^{-1} = yield in t.ha^{-1}, kontrola = control, průměr 30 let = average over 30 years

The most authors (Pronczuk, Pawlat, 1977; Regal, Veselá, 1981; Velich et al., 1982; Zelená, 1988; Mrkvička et al., 1997) present that increased nitrogen nutrition significantly reduces original species composition and at the same time their representation and viability are lowered in some components.

The type of meadow foxtail (*Alopecuretum*) is one of the most significant, highly productive meadow stands. According to the level of nutrition in long-term investigation in the years 1966 to 1990 average yield 5.2 t.ha^{-1} of hay was found (Table III, Fig. 1) in the control variant. The lowest yield of the stand was recorded in 1983 (2.8 t.ha^{-1} of hay), and the highest in 1967 (10.8 t.ha^{-1}). In the variant fertilized only with P_{40} K_{100}, average yield was 5.6 t.ha^{-1} of hay with marginal values of yields 3.3 t.ha^{-1} (1989) and 11.2 t.ha^{-1} of hay (1968). At nitrogen fertilization (200 kg N t.ha^{-1}) average long-term yields 8.6 t.ha^{-1} with marginal values 4.3 t.ha^{-1} (1989) and 16.0 t.ha^{-1} (1967) were recorded. The highest yields of dry matter in investigated variants were reached in the first three years of investigations (1966 to 1968).

Stability of yielding potential of foxtail stands varies in dependence on the course of climatic conditions (Hrabě, Halva, 1987) and at nitrogen nutrition (Regal, Veselá, 1981; Velich et al., 1982; Zelená, 1988 etc.). Pratotechnics, particularly fertilization and utilization, are among other factors affecting yields (Rychnovská et al., 1985). Regal and Veselá (1981) found average yield 5.7 t.ha^{-1} of hays in 32 foxtail stands. With growing altitude yields of stands are falling from 7.3 t.ha^{-1} in maize-growing region even to 4.2 t.ha^{-1} in subalpine zone.

Table IV documents average five-year dry matter and relative comparison with the control variant. It is evident from the table that variants fertilized only with PK do not manifest statistically significant difference compared with control areas and variants when 200 kg N t.ha^{-1} (+PK) were applied are statistically significantly different from unfertilized on both levels of significance.

Practical possibilities to maintain the stability of yields at limited energy inputs follow from the results of the study of development of species composition of meadow stands at long-term N fertilization (+PK). Under extraordinary situations it is possible to increase yields of foxtail stands very fast by supply of N fertilizers. At present optimally utilized stands of foxtail type provide ecological utilization of agricultural soil in the territories of greater protection of water resources against contamination by undesired substances.

It will be suitable to increase the attention at breeding rhizomatous cultural grasses, particularly of meadow foxtail and smooth-stalked meadow grass

IV. Average yields of dry fodder (in t.ha^{-1}) at different level of fertilization in the years 1966 to 1990, relative values (control = 100%) and variance analysis, Černíkovice

Period of years	Variants of fertilization				
	control	P_{40} K_{100}	relatively	N_{200} (+PK)	relatively
1966–1970	9.44	9.80	103.8	12.81	135.6
1971–1975	5.96	6.43	107.8	9.30	156.0
1976–1980	4.76	4.87	109.1	8.90	199.3
1981–1985	3.45	3.82	110.7	7.32	212.2
1986–1990	4.12	4.37	106.2	6.00	145.7
1991–1995	3.80	4.34	114.1	7.47	196.4
LSD 0.05 *F*		0.4531		29.8155*	
F crit.		4.0068		4.0068	
LSD 0.01 *F*		0.4531		29.8155**	
F crit.		7.0931		7.0931	

which are decisive fodder species of long-term fertilized stands with higher N rates.

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MRKVIČKA, J. - VESELÁ, M. (Česká zemědělská univerzita, Agronomická fakulta, Praha, Česká republika):

Druhová diverzita a výnosy psárkového porostového typu (*Alopecuretum*) při různém hnojení.

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Psárkový porostový typ (*Alopecuretum*) představuje rostlinné společenstvo s určitými dominantními druhy, který se rozšiřuje převážně na mezofytních až mezohygrofytních stanovištích ve všech výrobních oblastech. Hlavními faktory rozhodujícími o pokryvnosti a dominanci (D) *Alopecurus pratensis* jsou vláha a dusík. Cílem studie je vyhodnocení změn v dominanci jednotlivých agrobotanických skupin a druhů v letech 1966 až 1995. Sledování byla prováděna na původním porostu, při hnojení P_{40} K_{100} a N_{200} (+PK).

Nejvyšší celková pokryvnost byla u varianty hnojené N_{200} P_{40} K_{100}, u původního porostu došlo k 10% a u plochy s aplikací P_{40} K_{100} k 18% snížení této pokryvnosti v posledních letech sledování (tab. I). Nejvyšší zastoupení travní složky bylo u varianty hnojené N (94 %), kde došlo k redukci jetelovin a ke snížení ostatních dvouděložných druhů.

Nejvyšší procento dominance *Alopecurus pratensis* bylo zaznamenáno při aplikaci N. Postupně v letech sledování docházelo ke snížení dominance z 78 % na 59 % a k rozšíření ostatních dvouděložných výběžkatých trav (tab. II). Podobná tendence dominance psárky luční a ostatních rhizomatických trav byla u kontrolní varianty, kde došlo ke zvýšení dominance volně trsnatých trav. Při hnojení P_{40} K_{100} dominance výběžkatých trav měla klesající tendenci a rozšířily se volně trsnaté trávy. Zastoupení ostatních dvouděložných bylin bylo v průběhu let téměř na stejné úrovni.

Výnosová schopnost *Alopecureta* je variabilní a je ovlivněna trofosérií a hygrosérií stanoviště. U původního porostu se výnosy suché píce pohybovaly od 10,82 $t.ha^{-1}$ (rok 1967) do 2,81 $t.ha^{-1}$ (rok 1983). Průměrný výnos suché píce u kontrolní varianty za 30 let byl 5,21 $t.ha^{-1}$ (obr. 1). Zvýšení výnosu suché píce oproti kontrole bylo zaznamenáno při samotném PK-hnojení, a to o 7,6 %, tj. o 5,6 t. ha^{-1}. Každoroční dusíkaté hnojení v dávce 200 kg $N.ha^{-1}$ (+PK) mělo výrazný vliv na tvorbu nadzemní biomasy. Nejvyšší výnos (15,98 $t.ha^{-1}$) byl zjištěn v roce 1967, naopak nízký výnos byl v suchém roce 1989 (4,25 $t.ha^{-1}$). Dusíkem hnojená varianta byla oproti kontrole ve 30letém sledování o 67 % výnosnější (tab. III).

Varianty hnojené pouze PK nevykazovaly statisticky průkazný rozdíl oproti kontrolním plochám a varianty s aplikací 200 kg $N.ha^{-1}$ (+PK) se statisticky průkazně lišily od nehnojených variant na obou hladinách významnosti (tab. IV).

Z výsledků studia vývoje druhového složení lučních porostů při dlouhodobém N-hnojení (+PK) vyplývají praktické možnosti pro udržení stability výnosů při omezených energetických vkladech. Při mimořádných situacích lze velmi rychle zvýšit výnosy psárkových porostů dodáním N-hnojiv. Optimálně využívané porosty psárkového typu v současnosti zajišťují ekologické využití zemědělské půdy v územích zvýšené ochrany vodních zdrojů před kontaminací nežádoucími látkami.

psárkový porostový typ; dominance; výnosy

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