

Yield evaluation of varieties from the world collection of birdsfoot trefoil (*Lotus corniculatus* L.)

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ABSTRACT

In field trials in 1998–2000, ten varieties of the world collection of birdsfoot trefoil (*Lotus corniculatus*) were evaluated for herbage and hay yields. In all the years of testing yields from three cuttings and total annual production were evaluated. In 1999, seed yield was also recorded. As a control, alfalfa (*Medicago sativa*) variety was included in the experiment. The test varieties showed good productivity in the first and especially in the second year of testing, most of them exceeded alfalfa in herbage yield in individual cuttings and in total productions. As for hay yield, the differences were not so great. Local varieties showed very good productivity, predominantly in herbage yields. Of foreign varieties, the best herbage, hay and seed yielder was the Hungarian variety Puszta. There were no statistical differences in seed yield between the varieties. The yields were, however, relatively low.

Keywords: *Lotus corniculatus* L.; herbage yield; hay yield; seed yield

Birdsfoot trefoil is highly valued worldwide for its adaptability to a wide range of soil conditions, persistence in mixtures and grazing potential (Pop 1969). It is also valuable as a previous crop, predominantly for a large amount of post-harvest residues and its ability to fix atmospheric nitrogen by nodule bacteria. According to Pelikán and Hofbauer (1999), this crop belongs to species with the highest potential of fixation of atmospheric nitrogen. Pank (1973) rates this species the second important, preceded only by alfalfa. The problem is seed production in birdsfoot trefoil, which is caused predominantly by pod dehiscence. Birdsfoot is among the plants, which contain cyanogenic glycosides. During grazing HCN releases. The amount, absorbed by the organism and which is toxic, does not only depend on the content of cyanogens and enzymes, but also on the amount of pasture crop, rate of digestion and rumen fill (Devetak et al. 1971, 1972). This is the reason why great attention is given to variety trials (Davies 1969, Carlson 1973, and others).

MATERIAL AND METHODS

In the years 1998–2000, a world collection of birdsfoot trefoil (*Lotus corniculatus* L.) was studied in field trials. The trials were established in a randomised block design with three replications for forage and three replications for seed. The size of the plot was 5 m². This field trial was conducted at the altitude of 280 meters, on degraded chernozem soil. The list of evaluated varieties is in the Table 1. Alfalfa (*Medicago sativa* L.) variety Palava served as a control. In all the three years, three herbage cuttings were made. In 1998 the first cutting was made on 30 June, the second cutting on 10 August and the

third cutting on 21 September. In the second year (1999) the first cutting was on 19 May, the second on 25 June and the third on 6 August. In the third year, the three cuttings were made on 15 May, 30 June and 7 October, respectively. In the second harvest year seed yield was also evaluated.

RESULTS AND DISCUSSION

Herbage yields from the year of seeding and in the two harvest years, after conversion to t.ha⁻¹, are given in Table 2. Apart from yields, variety ranking in individual cuttings and conversion to percent of the control (*Medicago sativa*) are also shown. The results of analysis of variance for individual cuttings and the total annual production are presented in Table 3.

In the year of establishment, analysis of variance did not reveal any statistical differences between varieties

Table 1. The survey of varieties included into the trial

No.	Variety	Country
1	Malejovský	CSK
2	Lotar	CSK
3	Polom	SVK
4	Upstart	CAN
5	Bull	CAN
6	Leo	CAN
7	Skrzeszowicka	POL
8	Mirabel	CAN
9	Szabolci-1	HUN
10	Puszta	HUN

Table 2. Herbage yields (t.ha⁻¹) in individual cuttings and total annual production in individual years of testing

Variety	1 st cutting			2 nd cutting			3 rd cutting			Total		
	yield	% K	ranking	yield	% K	ranking	yield	% K	ranking	yield	% K	ranking
1998												
1	21.00	101.6	5.5	38.00	100.9	9.0	19.34	107.4	2.0	78.34	102.6	3.0
2	21.00	101.6	5.5	41.00	108.9	3.0	16.00	88.9	7.0	78.00	102.2	5.0
3	22.00	106.5	3.0	39.00	103.5	7.0	17.66	98.2	5.5	78.66	103.1	2.0
4	24.00	116.1	1.0	38.66	102.7	8.0	13.00	72.2	10.0	75.66	99.1	9.0
5	20.34	98.4	8.5	42.00	111.5	1.0	13.66	75.9	8.0	76.00	99.6	8.0
6	22.66	109.7	2.0	37.34	99.1	11.0	13.34	74.1	9.0	73.34	96.1	10.0
7	20.34	98.4	8.5	39.34	104.4	6.0	18.34	101.9	3.0	78.02	102.2	4.0
8	17.00	82.3	11.0	41.66	110.6	2.0	10.66	59.3	11.0	69.32	90.8	11.0
9	18.34	88.7	10.0	40.34	107.1	4.5	17.66	98.2	5.5	76.34	100.0	6.0
10	21.66	104.8	4.0	40.34	107.1	4.5	20.00	111.1	1.0	82.00	107.0	1.0
11	20.66	100.0	7.0	37.66	100.0	10.0	18.00	100.0	4.0	76.32	107.4	7.0
1999												
1	41.34	99.2	6.0	35.34	117.8	2.0	33.66	129.5	1.0	110.33	113.0	1.0
2	39.00	93.6	10.0	36.66	122.2	1.0	32.00	123.1	3.0	107.67	110.2	4.0
3	43.34	104.0	2.5	32.00	106.7	6.5	29.00	111.5	8.0	104.67	107.2	6.0
4	43.34	104.0	2.5	31.66	105.6	9.0	30.00	115.4	6.5	105.00	107.5	5.0
5	38.66	92.8	11.0	33.34	111.1	4.0	30.66	118.0	5.0	102.67	105.1	8.0
6	39.34	94.4	8.5	32.00	106.7	6.5	32.66	125.6	2.0	104.00	106.5	7.0
7	40.34	96.8	7.0	30.00	100.0	10.5	28.66	110.3	9.0	99.00	101.4	9.0
8	39.34	94.4	8.5	32.00	106.7	6.5	27.00	103.9	10.0	98.33	100.7	10.0
9	46.66	112.0	1.0	32.00	106.7	6.5	30.00	115.4	6.5	108.67	111.3	2.0
10	42.00	100.8	4.0	35.00	116.7	3.0	31.34	120.5	4.0	108.33	110.9	3.0
11	41.66	100.0	5.0	30.00	100.0	10.5	26.00	100.0	11.0	97.67	100.0	11.0
2000												
1	27.34	86.3	3.0	25.00	58.1	7.0	6.34	57.6	3.0	58.68	68.5	4.0
2	28.00	88.4	2.0	26.00	60.5	6.0	5.66	51.5	5.0	59.66	69.6	2.0
3	24.00	75.8	4.5	22.00	51.2	9.0	5.34	48.5	6.5	51.34	59.9	9.0
4	18.00	56.8	10.0	30.00	69.8	3.0	4.34	39.4	8.5	52.34	68.9	7.0
5	21.34	67.4	8.0	21.00	48.8	10.0	4.34	39.4	8.5	46.68	54.5	10.0
6	17.66	55.8	11.0	18.00	41.9	11.0	3.00	27.3	11.0	38.66	45.1	11.0
7	21.50	74.2	7.0	32.00	74.4	2.0	5.34	48.5	6.5	58.84	71.0	3.0
8	19.34	61.1	9.0	28.50	66.3	4.0	4.00	36.4	10.0	51.84	60.5	8.0
9	23.66	74.7	6.0	27.00	62.8	5.0	6.00	54.6	4.0	56.66	66.2	6.0
10	24.00	75.8	4.5	24.00	55.8	8.0	9.00	81.8	2.0	57.00	66.5	5.0
11	31.66	100.0	1.0	43.00	100.0	1.0	11.00	100.0	1.0	85.66	100.0	1.0

except the third cutting where statistically significant differences between varieties were found. In the first cutting of the seeding year (1998) the yields of birdsfoot trefoil ranged from 17.0 to 24.0 t.ha⁻¹, in the second cut-

ting from 37.3 to 42.0 t.ha⁻¹ and in the third cutting from 10.7 to 20.0 t.ha⁻¹. The total annual production was 69.3 to 82.0 t.ha⁻¹. In the first cutting, the highest yielding variety was Upstart, in the second cutting the variety Bull

Table 3. Results of analysis of variance of herbage yields in individual cuttings and total annual production

Source of variability	Year	<i>f</i>	<i>MS</i>			
			1 st cutting	2 nd cutting	3 rd cutting	total
Varieties	1998	10	11.09	7.74	27.56*	31.55
	1999	10	17.56	13.79	16.34	58.22
	2000	10	56.55**	134.46**	16.02**	405.10**

* $P > 0.05$, ** $P > 0.01$

Table 4. Hay yields (t.ha⁻¹) in individual cuttings and total annual production in individual years of testing

Variety	1 st cutting			2 nd cutting			3 rd cutting			Total		
	yield	% K	ranking	yield	% K	ranking	yield	% K	ranking	yield	% K	ranking
1998												
1	3.64	67.0	9.0	8.72	87.9	8.0	4.10	86.4	4.0	16.46	81.9	7.0
2	4.04	74.4	5.0	9.90	99.9	5.0	3.86	81.4	5.0	17.80	88.6	5.0
3	3.84	70.5	6.0	8.44	85.1	9.0	3.82	80.6	6.0	16.10	80.1	8.0
4	4.80	88.2	3.0	8.92	89.9	7.0	3.00	63.2	9.0	16.72	83.2	6.0
5	3.66	67.4	8.0	11.38	114.8	1.0	3.70	78.2	7.0	18.74	93.3	3.0
6	4.86	89.5	2.0	6.92	69.7	11.0	2.48	52.2	10.0	14.26	73.8	11.0
7	4.08	75.0	4.0	10.58	106.8	2.0	4.54	104.1	3.0	19.20	97.5	2.0
8	2.92	53.8	11.0	10.08	101.8	3.0	1.92	40.4	11.0	14.92	74.3	9.0
9	3.44	63.2	10.0	7.48	75.5	10.0	3.28	69.2	8.0	13.20	74.0	10.0
10	3.72	68.3	7.0	9.68	97.7	6.0	4.80	101.3	1.0	18.20	90.5	4.0
11	5.44	100.0	1.0	9.92	100.0	4.0	4.74	100.0	2.0	20.10	100.0	1.0
1999												
1	5.72	71.5	5.5	6.38	134.8	1.0	6.32	85.7	7.0	18.42	87.6	5.0
2	5.10	63.7	8.0	6.20	109.4	2.0	5.82	79.0	8.0	17.12	81.4	8.0
3	5.48	68.5	7.0	6.02	106.4	4.0	6.96	94.5	6.0	18.46	87.8	4.0
4	5.86	73.2	3.0	6.04	106.8	3.0	5.26	71.3	11.0	17.16	81.5	7.0
5	4.12	51.4	11.0	5.10	90.1	9.0	7.84	106.5	3.0	17.06	81.2	9.0
6	4.74	59.3	9.0	5.00	88.3	10.0	8.56	116.1	2.0	18.30	87.0	6.0
7	5.84	73.0	4.0	4.30	75.9	11.0	5.74	77.8	9.0	15.88	75.5	10.0
8	4.68	58.4	10.0	5.24	92.7	7.0	5.40	73.3	10.0	15.32	72.9	11.0
9	6.44	80.4	2.0	5.32	94.1	6.0	7.32	99.4	5.0	19.08	90.8	3.0
10	5.72	71.6	5.5	5.18	91.6	8.0	8.64	117.3	1.0	19.54	93.1	2.0
11	8.00	100.0	1.0	5.66	100.0	5.0	7.36	100.0	4.0	21.02	100.0	1.0
2000												
1	4.75	57.0	3.0	4.35	38.4	7.0	1.34	46.2	5.0	10.44	46.3	6.0
2	5.39	64.7	2.0	5.00	44.2	5.0	1.36	46.9	4.0	11.75	52.1	3.0
3	4.19	50.2	6.0	3.84	33.9	10.0	1.15	39.8	7.0	9.18	40.7	9.0
4	3.60	43.2	10.0	6.00	53.0	3.0	1.00	34.5	9.0	10.60	47.0	5.0
5	3.85	46.2	8.0	3.78	33.4	11.0	1.17	40.5	6.0	8.80	39.0	10.0
6	3.79	45.5	9.0	3.87	34.2	9.0	0.56	19.3	11.0	8.22	36.5	11.0
7	4.72	56.6	4.0	6.42	56.7	2.0	1.43	49.4	3.0	12.57	55.8	2.0
8	3.32	39.8	11.0	4.90	43.3	6.0	0.97	33.3	10.0	9.19	40.7	8.0
9	4.44	53.3	5.0	5.07	44.8	4.0	1.11	38.2	8.0	10.61	47.1	4.0
10	4.11	49.4	7.0	4.12	36.4	8.0	2.16	74.5	2.0	10.39	46.1	7.0
11	8.33	100.0	1.0	11.32	100.0	1.0	2.90	100.0	1.0	22.55	100.0	1.0

and in the third cutting as well as in the total annual production the variety Puszta.

In the first cutting alfalfa was exceeded in herbage yield by 6 varieties of birdsfoot trefoil, in the second cutting

by 9 varieties, in the third cutting by 3 varieties and in the total annual production by 6 varieties.

In 1999, analysis of variance did not show any statistical differences between the varieties tested. Herbage

Table 5. Results of analysis of variance of hay yields in individual cuttings and total annual production

Source of variability	Year	<i>f</i>	<i>MS</i>			
			1 st cutting	2 nd cutting	3 rd cutting	total
Varieties	1998	10	1.58**	5.31**	2.81**	10.82**
	1999	10	3.21	2.26**	4.45**	8.18**
	2000	10	5.67**	14.12**	1.22**	46.70**

* $P > 0.05$, ** $P > 0.01$

yields in the first cutting fluctuated from 38.7 to 46.7 t.ha⁻¹, in the second cutting from 30.0 to 36.7 t.ha⁻¹, in the third cutting from 27.0 to 33.7 t.ha⁻¹ and in the total annual production from 98.3 to 110.3 t.ha⁻¹. The highest yield was produced in the first cutting by Szabolci-1, in the second cutting by Lotar, in the third cutting and in the total annual production by Malejovský. In the first cutting of this year, alfalfa was out yielded by 4 trefoil varieties, in the second cutting by 9 varieties, in the third cutting by 10 varieties and in the total annual production also by all 10 varieties of birdsfoot trefoil.

In the last year of testing (2000) analysis of variance revealed statistically highly significant differences between varieties in all three cuttings and in the total annual production. This was caused predominantly by high herbage yields in alfalfa. In the first cutting of the year, alfalfa highly significantly out yielded all test varieties of birdsfoot trefoil, except for the local varieties Malejovský and Lotar, in the second and third cuttings and in the total annual production it highly significantly out yielded all test varieties of birdsfoot trefoil. In this year there were, however, statistically highly significant differences even between the test varieties of birdsfoot trefoil. In the first cutting the local varieties Malejovský and Lotar out yielded the varieties Upstart, Bull, Leo and Mirabel and also the varieties Puszta, Polom, Szabolci-1 and Skrzyszowicka highly significantly out yielded the varieties Upstart and Leo. In the second cutting there were highly significant differences between all the test varieties, in the third cutting only the variety Puszta highly significantly out yielded the varieties Polom, Upstart, Bull, Leo, Skrzyszowicka and Mirabel. As for the total annual production, the varieties Skrzyszowicka, Lotar, Upstart, Malejovský, Puszta and Szabolci-1 highly significantly out yielded the varieties Bull and Leo and the varieties Mirabel and Polom outyielded the variety Leo.

Herbage yields in the first cutting ranged from 17.7 to 28.0 t.ha⁻¹, in the second cutting from 18.0 to 32.0 t.ha⁻¹, in the third cutting from 3.0 to 9.0 t.ha⁻¹ and in the total annual production from 38.7 to 59.7 t.ha⁻¹. The highest yield in the first and the second cutting of this year was produced by the Polish variety Skrzyszowicka, in the third cutting by the variety Puszta and in the total annual production by the local variety Lotar. None of the test varieties of birdsfoot trefoil out yielded alfalfa in this year.

Hay yields (converted to t.ha⁻¹) are given in Table 4. The results of analysis of variance for individual cuttings and the total annual production are presented in Table 5. In contrast to herbage yields, analysis of hay yields revealed statistically highly significant differences between test varieties in all cuttings and the total annual production except for the first cutting of the year 1999. The varieties showing the differences are presented in Table 6.

In the first cutting of the year of establishment, the yields of birdsfoot trefoil ranged from 2.9 to 4.9 t.ha⁻¹ and

Table 6. Survey of treatments in which analysis of variance revealed statistically highly significant differences in hay yields

1998	1 st cutting	11 > 1, 3, 5, 7, 8, 9, 10
		6 > 8, 9
		4 > 8, 9
	2 nd cutting	5, 7 > 1, 3, 4, 6, 9
		8 > 3, 6, 9
		11, 2, 10 > 6, 9
	3 rd cutting	4, 1 > 6
		7 > 4, 6, 8
		10, 11 > 6, 8
	total	1, 2, 3 > 8
11 > 1, 3, 4, 6, 8, 9		
7 > 3, 6, 8, 9		
1999	1 st cutting	5, 10 > 6, 8, 9
		1 > 3, 4, 5, 6, 7, 8, 9, 10, 11
		2 > 5, 7
	2 nd cutting	4, 3 > 7
		10, 6 > 1, 2, 3, 4, 7, 8
		5 > 2, 4, 7, 8
	3 rd cutting	11, 9 > 4, 7, 8
		3 > 4
		11 > 1, 2, 3, 4, 5, 6, 7, 8
	total	10 > 2, 5, 7, 8
9, 3, 1 > 7, 8		
6 > 8		
2000	1 st cutting	11 > 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
		2 > 3, 4, 5, 6, 8, 10
		1, 7 > 4, 8
	2 nd cutting	9 > 8
		11 > 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
		11 > 1, 2, 3, 4, 5, 6, 7, 8, 9
	3 rd cutting	10 > 1, 2, 3, 4, 5, 6, 8, 9
		7, 2 > 6
		10 > 1, 2, 3, 4, 5, 6, 7, 8, 9, 10
	total	7 > 1, 3, 4, 5, 6, 8, 9, 10
2 > 3, 5, 6, 8		
9, 4 > 5, 6		
		1, 10 > 6

the highest yield was produced by the Polish variety Skrzyszowicka. In the second cutting the yields fluctuated from 6.9 to 11.4 t.ha⁻¹ and the top yielder was the Canadian variety Bull. In the third cutting the yields were between 1.9 and 4.8 t.ha⁻¹ and the top yielding variety was the Hungarian variety Puszta. The total annual production of hay in this year was 14.3 to 19.2 t.ha⁻¹. The highest yield was achieved by the Polish variety Skrzyszowicka.

In the first cutting of the second year hay yields ranged from 4.1 to 6.4 t.ha⁻¹ and the highest yield was produced by the Hungarian variety Szabolci-1, in the second cutting the yields were 4.3 to 6.4 t.ha⁻¹ and the top yielding

Table 7. Seed yields in the year 1999

No.	Variety	t.ha ⁻¹	% K	Ranking
1	Malejovský	0.295	100.0	8
2	Lotar	0.330	111.7	5
3	Polom	0.285	96.6	10
4	Upstart	0.290	98.2	9
5	Bull	0.333	112.6	4
6	Leo	0.340	115.1	3
7	Skrzeszowicka	0.322	109.0	6
8	Mirabel	0.305	103.2	7
9	Szabolci-1	0.347	117.4	2
10	Puszta	0.409	138.6	1

variety was the local variety Malejovský. Finally, in the third cutting, the yields were 5.3 to 8.6 t.ha⁻¹ and the highest yield, like in the previous year, was provided by the Hungarian variety Puszta. The total annual production of this year ranged from 15.3 to 19.5 t.ha⁻¹ and the Hungarian variety Puszta ranked high again.

In the third year of testing hay yields in the first cutting ranged from 3.3 to 5.4 t.ha⁻¹ and the highest yield was given by the local variety Lotar. In the second cutting the yields were in the range of 3.8 to 6.4 t.ha⁻¹ and the top yielding variety was Skrzyszowicka and in the third cutting the yields were between 0.6 to 2.2 t.ha⁻¹ and Puszta was the top yielder. As for the total annual production in the third year of testing, the yields ranged from 8.2 to 12.6 t.ha⁻¹ and the Polish variety Skrzyszowicka was the best.

Good herbage yields were produced by the local varieties Malejovský and Lotar, which during the whole time of testing ranked in the top half of the collection. Slightly poorer were these varieties in hay yields. Their yields were rather at the beginning of the bottom half of the collection. In individual cuttings and in the total annual production of herbage, predominantly in the first two years of testing, a large number of birdsfoot trefoil varieties

out yielded alfalfa. In the second, the third cutting, and the total production of the second year of testing alfalfa was exceeded by all ten birdsfoot trefoil varieties. As for hay yields, the dominance of trefoil varieties was not so marked.

Seed yields studied in the second experimental year (1999) are presented in Table 7. Analysis of variance failed to reveal any statistical differences between test varieties. Seed yields ranged from 0.28 to 0.41 t.ha⁻¹ and the highest yield was produced by the Hungarian variety Puszta. Of local varieties, Lotar produced a relatively high yield, exceeding the variety Malejovský by 11.7%.

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ABSTRAKT

Zhodnocení výnosů odrůd světového sortimentu štirovníku růžkatého (*Lotus corniculatus* L.)

V polním pokuse bylo v letech 1998 až 2000 hodnoceno deset odrůd světového sortimentu štirovníku růžkatého (*Lotus corniculatus*) z hlediska výnosů zelené hmoty a sena. Ve všech letech byly hodnoceny výnosy ve třech sečích a v celkových ročních produkcích. V roce 1999 byl zjišťován také výnos semene. Jako kontrola byla do pokusu zařazena odrůda vojtěšky seté (*Medicago sativa*). Sledované odrůdy prokázaly dobrou výkonnost, v prvním a zvláště ve druhém roce pokusu v jednotlivých sečích i v celkových produkcích řada z nich překonávala svým výnosem zelené hmoty vojtěšku setou. V celkové roční produkci zelené hmoty měla v prvním pokusném roce nejvyšší výnos maďarská odrůda Puszta (82,0 t.ha⁻¹), ve druhém roce tuzemská odrůda Malejovský (110,3 t.ha⁻¹) a ve třetím roce česká odrůda Lotar s výnosem 59,7 t.ha⁻¹. Ve výnosech sena již tyto rozdíly tak markantní nebyly. V prvním pokusném roce byla dosažena nejvyšší roční produkce u polské odrůdy Skrzyszowicka (19,2 t.ha⁻¹), ve druhém roce u maďarské odrůdy Puszta (19,5 t.ha⁻¹) a ve třetím roce opět u polské odrůdy Skrzyszowicka (12,6 t.ha⁻¹). Domácí odrůdy Lotar a Malejovský prokázaly velmi dobrou výkonnost, především ve výnosech zelené hmoty. Ze zahraničních odrůd měla velmi dobrou výkonnost ve výnosech zelené hmoty, sena a semene

maďarská odrůda Puszta. Ve výnose semene nebyly zjištěny statistické rozdíly mezi sledovanými odrůdami, výnosy však byly poměrně nízké. Z domácích odrůd měla vyšší výnos odrůda Lotar, která odrůdu Malejovský překonala o 11,7 %.

Klíčová slova: *Lotus corniculatus* L.; výnos zelené hmoty; výnos sena; výnos semen

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