ROOTS AND ENERGY YIELD OF FODDER BEET IN ORGANIC FARMING*

H. Honsová, L. Bečková, J. Pulkrábek

Czech University of Life Sciences, Faculty of Agrobiology, Food and Natural Resources, Department of Crop Production, Prague, Czech Republic

Six fodder beet varieties were compared in experiments at ecological area in Uhříněves. The most yielding varieties counts were reached by the variety Hako, which in two years gave the highest yield of bulbs (in average 98,8 t.ha^{-1}). In 2005 high yield reached also the variety Monro, what was not confirmed in 2006. Present fodder beet varieties are suitable for ecological farming. High yield in 2005 had the varieties Monro, Hako and Kostelecká Barres and in 2006 the varieties Hako and Jamon. Energy value of fodder beet bulbs was statistically significant to the variety and year of growing. High energy value showed, except cultivar Merak, also fodder beet cultivars Starmon and Jamon.

fodder beet; varieties; ecological farming; energy value

INTRODUCTION

Fodder beet areas in the Czech Republic are diminishing. In 2006 they reached only 839 ha. This crop has very high feed quality. Fodder beet could be used in organic farming, i.e. as an excellent feed for dairy cows and other animals. Fodder beet increases biodiversity of growed crops in organic farming.

Fodder crops with wide ratio of nutrients – fodder beet, semi-sugar beet and sugar beet – provide more energy in comparison with cereals or forage crops (Urban et al., 2005; Žák et al., 2006). Fodder beet provides a maximum amount of energy per hectare and presents an easily digestible feed (Kosař et al., 1985). Fodder beet is due to its composition suitable solution of energy deficiency and fibre excess in winter feed rations (Šroller, Pulkrábek, 1993).

The most important factor determining nutritional quality of feeds is digestibility. Its value significantly influences amount of nutrients and energy available for animal (Kováč et al., 1989).

Significant energy value – brutto energy – is in fodder beet. Brutto energy (BE) is determined in calorimeter by complete combustion of feed in oxygen atmosphere and is expressed in megajoules (MJ). Energy value of feed for cattle is determined in megajoules as NELs (for lactation cattle) and NEVs (for growing cattle – weight gain above 800 g/day). For energy content determination it is also necessary to determine metabolized energy content for cattle (MEs) (Zeman, 2006).

Fodder beet in ecological systems of growing is not only a good precrop, but it is first of all valuable feed for young and breeding animals.

MATERIAL AND METHODS

The aim of our research was to recommend chosen varieties of fodder beet for organic growing. During 2005 and 2006 small-plot trials were established (in four repetitions on plots with harvest area of ten square meters) with fodder beet on certified and controlled ecological area of Experimental Station of Department of Crop Production in Prague-Uhříněves.

Six cultivars of fodder beet were used in experiment – Lenka, Hako, Jamon, Monro, Kostelecká Barres, Starmon and sugar beet cultivar Merak (Table 1).

Table 1. Variants of variety experiment

Variety	Type	Resistance	Properties
Merak	sugar beet N/C	rhisomania, cercospora	2003 – diploid
Lenka	cubical	–	1992 – 2n, monogerm, yellow bulb, cylindrical form with blunt root termination
Hako	cubical	–	1977 – 3n, multigerm, light yellow bulb with orange shade, cylindrical with sudden termination
Kostelecká Barres	compromise	–	1937 – multigerm, orange bulb with olive shape, 1/3–1/2 in ground
Jamon	cubical	–	1997 – 3n, monogerm, yellow bulb
Monro	cubical	–	1994 – 3n, monogerm, red bulb
Starmon	compromise	rhisomania	monogerm, yellow bulb

* The study was financed by the grant of Ministry of Environment of the Czech Republic VaV 1C/4/8/04, Grant NAZV No. Q 650034 and research project 6046070901.

During vegetation stands were kept in non-weed state by inter-row hoeing and by manual hoeing and weeding in rows. No chemical protection against fungal diseases was used.

Number of plants per plot was determined before harvest. Harvest was performed by manual collection of roots. Average weight of one root was determined and also total yield per hectare was recorded.

Samples were evaluated by agriculture laboratory Malý a spol. in Žatec. Based on dry matter according to sucrose metabolized energy (MEs), brutto energy (BE), netto energy of lactation (NEL) and netto energy of fattening (NEV) were determined.

The results were evaluated by statistical program SAS using analysis of variance at significance level $\alpha = 0.05$. Confirmatively different values are marked with different letters (a, b, c, d) and non-confirmative are marked "ns".

RESULTS AND DISCUSSION

Yields of roots were strongly influenced by weather and by number of plants after singling. Due to timely sowing and favourable weather conditions in 2005 beet emerged well. In 2005 after singling we obtained balanced and high numbers of plants at individual plots. Long winter, late start of spring and drought in the period after sowing in 2006 caused lower emergence. In 2006 total numbers in individual variants were relatively low in order to achieve relative uniformity between plots. It proved that seeds quality and protection of emerging sugar beet plants will be very important for ecological growing. Kristek and Kristek (2006) say that inoculation of seeds with *Pseudomonas fluorescenc* could be one of the possibilities.

Lower number of plants and drought caused lower average per hectare yield of roots in 2006. In 2005 cultivars Monro, Starmon, Hako and Kostelecká Barres reached yields of roots above one hundred tons per hectare, in 2006 none of varieties exceeded this level (Table 2). In 2006 the highest yields were reached in the cultivars Hako and Jamon (Table 2). The lowest yields in 2005 were obtained in the varieties Lenka and Jamon, and in 2006 it was in the cultivars Kostelecká Barres and Starmon. Higher yield in 2005 was caused by higher precipitation in July in the period of maximum growth and other favourable period with optimum precipitation until harvest.

Our experiments confirmed that the cultivar Hako is very economic. Monogerm French cultivars Monro, Starmon and Jamon, delivered with high quality of seed, are equivalent to domestic varieties. In organic growing complexity of stand is very important, because it is the first condition for high yields and it ensures competitiveness of fodder beet plants against secondary weed infestation with goosefoots, pigweed and other weeds. Yield markers are very favourable, what is determined i.e. by suitable soil and growing conditions and by manual harvest with minimum of harvest losses.

Fodder beet cultivars even without chemical treatment against foliar diseases provide very good yields ensuring economic effectiveness of their growing (Fig. 1). Higher percentage of leaf diseases infestation (Table 4) in 2005 did not influence yields negatively. Early prognosis of some diseases occurrence, i.e. *Cercospora beticola*, is important. In this case we can use models for sugar beet growing (Spitzer, 2006).

Energy value of beet roots statistically confirmatively depended on cultivars and weather. Metabolizable energy was slightly higher in 2005, when in average it reached 1.78 $MJ.kg^{-1}$, while in 2006 this value was 1.65 $MJ.kg^{-1}$. The cultivar Merak reached 2.39 $MJ.kg^{-1}$. In fodder beets the highest values reached cultivars Starmon and Jamon (Table 3, Fig. 2).

Brutto energy reached in average of both years 2.37 $MJ.kg^{-1}$ and was slightly higher in 2005. Cultivar Merak showed the highest value – 3.24 $MJ.kg^{-1}$. There were not found any significant differences among fodder beets (Table 3, Fig. 2).

Netto energy of lactation was slightly higher in 2005. In total it reached in average of all cultivars 1.1 $MJ.kg^{-1}$. The highest NEL had cultivar Merak. In fodder beets higher NEL had cultivars Starmon and Jamon (Table 3, Fig. 2).

Netto energy of fattening was slightly higher in roots in 2005. In total this value reached 1.19 $MJ.kg^{-1}$. The highest NEV had the cultivar Merak, then followed the varieties Starmon and Jamon (Table 3, Fig. 2).

Presented results showed advantage of fodder beet also for ecological systems of production. Amount of production, nutrients content and energy are a good input into

Table 2. Yield of sugar beet and fodder beet roots

Variety	Plant number in harvest (thousand.ha^{-1})		Average weight of 1 root (g)		Root yield (t.ha^{-1})				
	2005	2006	2005	2006	average	2005		2006	
Merak	106	40.5	790	930	60.5	83.3	d	37.6	c
Lenka	85	48.5	1078	1640	85.0	90.9	bcd	79.0	ab
Hako	102	63.5	1047	1430	98.8	106.0	ab	91.5	a
Kostelecká Barres	110	38.0	955	1570	83.1	104.3	abc	61.8	bc
Jamon	94	63.8	944	1420	88.1	88.6	cd	87.5	ab
Monro	104	65.0	1051	1160	91.8	108.9	a	74.6	ab
Starmon	101	63.5	1055	1120	88.2	106.3	ab	70.1	ab

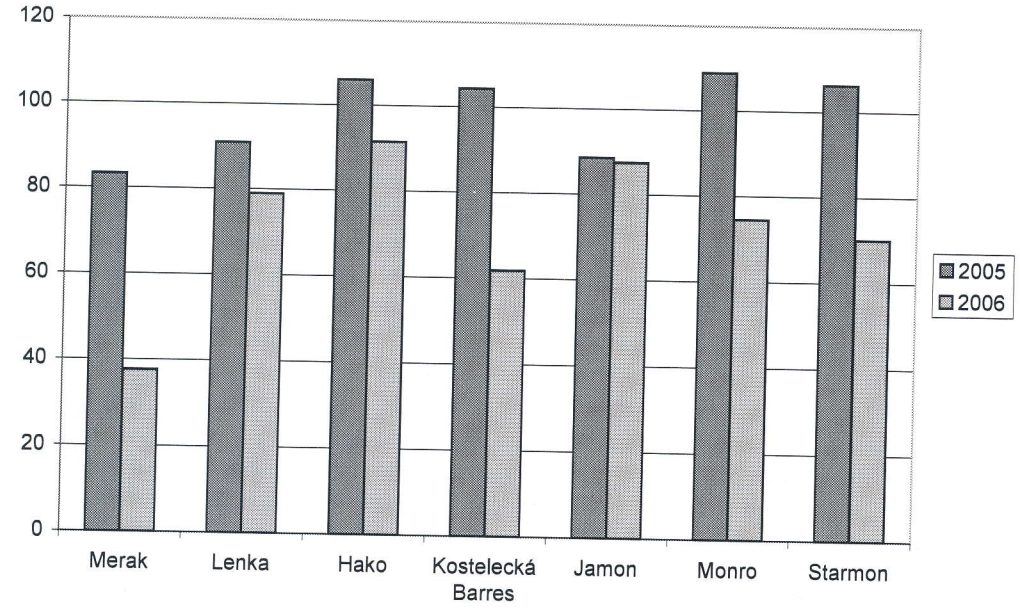

Fig. 1. Yields of beet roots in $t.ha^{-1}$

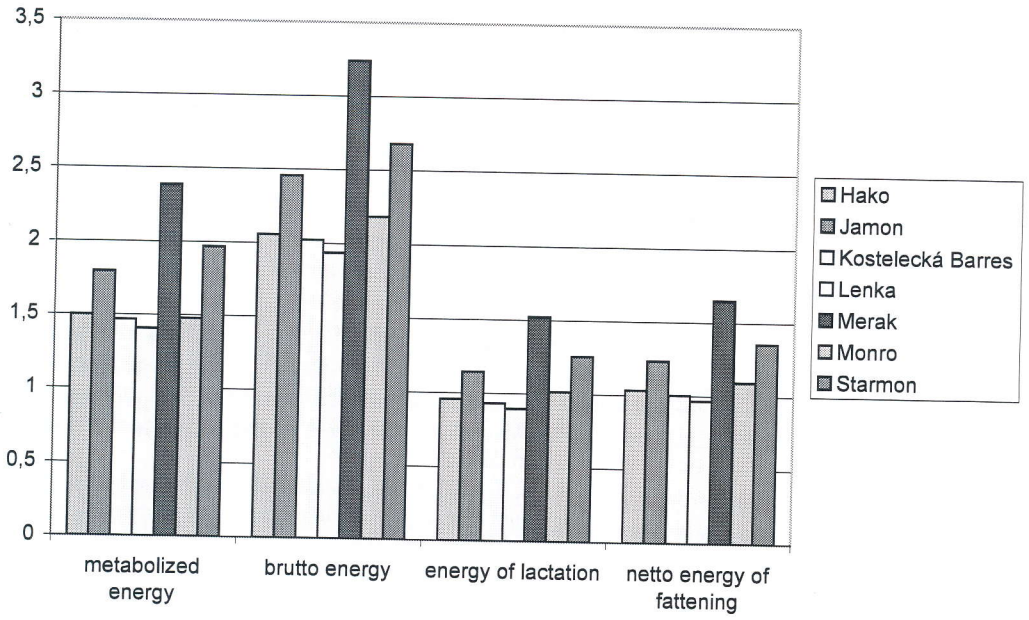

Fig. 2. Energy value of roots in $MJ.kg^{-1}$

winter food doses for animals in organic farming. Effectiveness of its growing is connected with the selection of suitable monogerm cultivars with fast initial growth of leaves apparatus. Cultivars should have half-erected leaf rosette, leaves should be middle up to long, blade should be oblong, leafstalk short up to middle.

CONCLUSION

In both the years – 2005 and 2006 – high yields of fodder beet roots were reached. The most yielding cultivar is Hako, which in both monitored years provided the highest root yield per hectare (in average 98.8 $t.ha^{-1}$). In 2005 the cultivar Monro reached high yield, but this was not confirmed in 2006.

French cultivars Monro, Starmon and Jamon are very yielding and regarding the quality of seed they are suitable also for modern technologies of growing. Evaluated cultivars of fodder beet are suitable also for the growing in organic farming.

In experiments high feed value of roots of monitored cultivars of fodder and sugar beet was proved. Though all energy values of ecological fodder beet and sugar beet were, in comparison with average values in the Feed Catalogue (Z e m a n et al., 1995), slightly lower, ecological fodder beet and sugar beet are the excellent feeds.

Influence of growing year and cultivar on all monitored factors of energy value in fodder beet was found. Metabolizable energy, brutto energy and netto energy of lactation and fattening reached higher values in 2005. Differences between cultivars were also found. High energy value showed, except cultivar Merak, also fodder beet cultivars Starmon and Jamon.

Table 3. Energy value of beet roots ($MJ.kg^{-1}$)

Cultivar	Year	Metabolized energy (MEs)		Brutto energy (BE)		Netto energy of lactation (NEL)		Energy of fattening (NEV)	
Hako	2005	1.55		2.11		0.99		1.07	
Hako	2006	1.46		2.01		0.93		1.00	
Hako	average	1.50	c	2.06	cd	0.96	cd	1.04	c
Jamon	2005	1.87		2.53		1.20		1.30	
Jamon	2006	1.72		2.39		1.10		1.18	
Jamon	average	1.80	bc	2.46	bc	1.15	bc	1.24	bc
Kostelecká Barres	2005	1.58		2.16		1.01		1.09	
Kostelecká Barres	2006	1.36		1.89		0.86		0.92	
Kostelecká Barres	average	1.47	c	2.02	cd	0.93	cd	1.01	c
Lenka	2005	1.49		2.03		0.95		1.03	
Lenka	2006	1.33		1.85		0.85		0.91	
Lenka	average	1.41	c	1.94	d	0.90	d	0.97	c
Merak	2005	2.53		3.41		1.62		1.76	
Merak	2006	2.25		3.07		1.43		1.55	
Merak	average	2.39	a	3.24	a	1.52	a	1.65	a
Monro	2005	1.40		2.22		1.04		1.12	
Monro	2006	1.56		2.16		1.00		1.07	
Monro	average	1.48	b	2.19	cd	1.02	cd	1.10	bc
Starmon	2005	2.03		2.75		1.30		1.41	
Starmon	2006	1.91		2.61		1.22		1.31	
Starmon	average	1.97	c	2.68	b	1.26	b	1.36	b

Table 4. Plant attack by leaf diseases

Variety	% of attacked leaves before harvest					
	2005			2006		
Merak	59	a		2		c
Lenka	89		b	22		b
Hako	99		b	26	a	b
Kostelecká Barres	94		b	30	a	b
Jamon	91		b	29	a	a
Monro	94		b	36	a	
Starmon	90		b	28	a	b

REFERENCES

KOSAŘ, J. et al.: Fodder Beet. Praha, SZN 1985. 302 pp.

KOVÁČ, M. et al.: Nutrition and feeding of live stock. Bratislava, Príroda 1989. 522 pp.

KRISTEK, S. – KRISTEK, A.: Inoculation of sugar beet seed by bacterium *Pseudomonas fluorescens* – alternative of chemical fungicides. Listy cukrov. a řepař., *122*, 2006 (2): 49–53.

SPITZER, T.: Comparison of various models of sugar beet protection against *Cercospora betiola*. Listy cukrov. a řepař., *122*, 2006 (9–10): 249–251.

ŠROLLER, J. – PULKRÁBEK, J.: Principles of Fodder Beet Growing. Institut výchovy a vzdělávání, Ministry of Agriculture CR, Prague, 1993. 32 pp.

URBAN, J. – HNILIČKA, F. – PULKRÁBEK J.: Content of energy in bulbs and tops of sugar beet. Listy cukrov. a řepař., *121*, 2005 (9–10): 282–285.

ZEMAN, L.: Nutrition and feeding of live stock. Profi Press 2006. 360 pp.

ZEMAN, L. et al.: Feeds Catalogue. VÚVZ Pohořelice, 1995. 465 pp.

ŽÁK, Š. – MACÁK, M. – KOVÁČ, K.: Energy balance of potato growing in ecological, low-input and conventional production system. Agriculture (Poľnohospodárstvo), *52*, 2006 (3): 132–143.

Received for publication on May 30, 2007
Accepted for publication on July 30, 2007

HONSOVÁ, H. – BEČKOVÁ, L. – PULKRÁBEK, J. (Česká zemědělská univerzita, Fakulta agrobiologie, potravinových a přírodních zdrojů, katedra rostlinné výroby, Praha, Česká republika):

Výnosy bulev a energie krmné řepy v ekologickém zemědělství.

Scientia Agric. Bohem., *38*, 2007: 157-161.

Cílem výzkumu bylo porovnání a doporučení vybraných odrůd krmné řepy pro ekologické pěstování na základě posouzení produkční schopnosti a porovnání jejich krmné hodnoty.

V dvouletých pokusech v letech 2005 a 2006 byly založeny maloparcelní pokusy (ve čtyřech opakováních na parcelkách o sklizňové ploše deset metrů čtverečních) s krmnou řepou na certifikované a kontrolované ekologické ploše Výzkumné stanice katedry rostlinné výroby v Praze-Uhříněvsi.

Do pokusů bylo zařazeno šest odrůd krmné řepy – Lenka, Hako, Jamon, Monro, Kostelecká Barres, Starmon a odrůda cukrové řepy Merak (tab. 1).

V průběhu vegetace byly porosty udržovány v bezplevelném stavu. Jednalo se o plečkování meziřádků a ruční okopávání a pletí v řádcích. Proti houbovým chorobám nebyla použita chemická ochrana.

Před sklizní byl zjištěn počet rostlin na parcele. Sklizeň proběhla ručním sběrem bulev, které byly na poli zváženy. Byla sledována průměrná hmotnost jedné bulvy a celkový výnos na hektar.

Vzorky vyhodnotila Zemědělská oblastní laboratoř Malý a spol. Žatec. Energetická hodnota řepných bulev byla stanovena pomocí hodnot (v sušině vzorků) metabolizovatelná energie (MEs), brutto energie (BE), netto energie laktace (NEL) a netto energie výkrmu (NEV).

V obou letech bylo dosaženo vysokých výnosů bulev. K nejvýnosnějším odrůdám patří odrůda Hako, která v obou sledovaných letech poskytla nejvyšší výnos bulev z jednoho hektaru (v průměru 98,8 $t.ha^{-1}$). V roce 2005 dosáhla vysokého výnosu i odrůda Monro, což se ale nepotvrdilo v roce 2006.

Francouzské odrůdy Monro, Starmon a Jamon jsou velmi výnosné a vzhledem ke kvalitě dodávaného osiva jsou vhodné i pro moderní technologie pěstování. Současné odrůdy krmné řepy jsou vhodné i pro pěstování v ekologickém zemědělství.

V pokusech se potvrdilo, že odrůda Hako je velice výnosná a pokud se podaří zajistit kvalitní osivo, které je prvním předpokladem kompletního porostu, a vysoký počet rostlin na 1 ha (70–90 tis. rostlin na 1 hektaru), bude trvale patřit k nejlepším odrůdám našeho sortimentu. Jednoklíčkové francouzské odrůdy Monro, Starmon a Jamon, dodávané s vysokou kvalitou osiva, jsou rovnocennými partnery stávajícím tuzemským odrůdám.

Odrůdy krmné řepy i bez chemické ochrany proti listových chorobám poskytnou velmi dobré výnosy zajišťující ekonomickou efektivnost jejich pěstování (obr. 1).

V pokusech byla prokázána vysoká krmná hodnota bulev sledovaných odrůd krmné řepy a cukrovky. V porovnání s průměrnými hodnotami uvedenými v Katalogu krmiv (Zeman et al., 1995) sice byly všechny sledované energetické hodnoty ekologické krmné řepy i cukrovky mírně snížené, ale i tak představuje ekologická krmná řepa vynikající krmivo.

Byl zjištěn vliv ročníku pěstování i odrůdy na všechny sledované faktory energetické hodnoty krmné řepy. Metabolizovatelná energie, brutto energie a netto energie laktace i výkrmu dosáhly vyšších hodnot v roce 2005. Byly zjištěny i rozdíly mezi odrůdami. Vysokou energetickou hodnotu vykázaly, kromě cukrovky Merak, odrůdy krmné řepy Starmon a Jamon.

krmná řepa; odrůdy, ekologické zemědělství, energetická hodnota

Contact Address:

Ing. Hana Honsová, PhD., Česká zemědělská univerzita v Praze, Fakulta agrobiologie, potravinových a přírodních zdrojů, katedra rostlinné výroby, Kamýcká 957, 165 21 Praha 6-Suchdol, Česká republika, tel.: +420 224 352 538, e-mail: honsova@af.czu.cz