THE EFFECT OF HARVEST GROWTH STAGE ON THE YIELD, CHEMICAL COMPOSITION AND METABOLIZABLE ENERGY OF SPRING BARLEY

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The field and laboratory experiments were carried out during the period of 1997–1999 at Lithuanian University of Agriculture. The aim of the trials was to find out accumulation dynamics of dry matter, digestible organic matter in the dry matter, chemical composition of dry matter and metabolizable energy for ruminants (cows) depending on growth stage and to determine the optimum growth stage for harvesting forage spring barley. Spring barley variety 'Roland' was grown which was harvested at the stem elongation, heading, early milk, medium milk, late milk-early dough, dough and caryopsis hard growth stages of maturity. When spring barley plants grow and develop, they gradually accumulate dry matter and metabolizable energy that reach the biggest amount at medium milk and late milk-early dough stages. In future stages of maturity dry matter yield and the amount of metabolizable energy decrease. The biggest dry matter yield of spring barley was gathered at early milk stage of maturity (1997) – 7.78 t ha^{-1}, in late milk-early dough stage (1998, 1999) – 7.03 t ha^{-1} and 5.80 t ha^{-1}, respectively. Harvesting spring barley in hard stage of maturity, dry matter yield decreased to 5.55 t ha^{-1} in 1997, 1998 – to 5.13 t ha^{-1}, 1999 – to 4.17 t ha^{-1}, it made 40%, 37% and 39%, respectively. The biggest amount of metabolizable energy was achieved by analogy with dry matter yield – in early milk stage (1997) – 65.2 Gj ha^{-1} , in late milk-early dough stage (1998 and 1999) – 68.0 Gj ha^{-1} and 50.1 Gj ha^{-1}, respectively. Harvesting spring barley in hard stage of maturity, the amount of metabolizable energy decreased to 50.7 Gj ha^{-1} (in 1997), to 46.8 Gj ha^{-1} (in 1998), to 36.0 Gj ha^{-1} (in 1999). It amounted 29%, 45% and 39%, respectively. Positive, statistically reliable, linear dependence of spring barley crude protein (t ha^{-1}) $r_{1997} = 0.736^{***}$, $r_{1998} = 0.317$, $r_{1999} = 0.858^{***}$, crude fibre (t ha^{-1}) $r_{1997} = 0.964^{***}$, $r_{1998} = 0.937^{***}$, $r_{1999} = 0.961^{***}$, crude fat (t ha^{-1}) $r_{1997} = 0.960^{***}$, $r_{1998} = 0.911^{***}$, $r_{1999} = 0.957^{***}$ and crude ash (t ha^{-1}) $r_{1997} = 0.689^{***}$, $r_{1998} = 0.335$, $r_{1999} = 0.646^{***}$ on dry matter yield (t ha^{-1}) and linear dependence of metabolizable energy (Gj ha^{-1}) on spring barley dry matter (t ha^{-1}), $r_{1997} = 0.992^{***}$, $r_{1998} = 0.985^{***}$, $r_{1999} = 0.983^{***}$, crude protein (t ha^{-1}) $r_{1997} = 0.750^{***}$, $r_{1998} = 0.420^{*}$, $r_{1999} = 0.844^{***}$, crude fibre (t ha^{-1}) $r_{1997} = 0.967^{***}$, $r_{1998} = 0.900^{***}$, $r_{1999} = 0.948^{***}$, crude fat (t ha^{-1}) $r_{1997} = 0.926^{***}$, $r_{1998} = 0.931^{***}$, $r_{1999} = 0.953^{***}$ and crude ash yields (t ha^{-1}) $r_{1997} = 0.671^{***}$, $r_{1998} = 0.385^{*}$, $r_{1999} = 0.576^{**}$ was established. When spring barley grain matures at hard growth stage compared with dough stage, the yield of DM, CP, crude fibre and ME increases. The yield of crude fat and CA almost does not differ. However, when the quality of straw becomes worse, the general value of yield remains lower than in milk-dough stage. According to the trial data of 3 years, spring barley used for forage may be harvested at the early milk, medium milk or late milk-early dough growth stages when the biggest yield is got of dry matter, their components and metabolizable energy.

spring barley; growth stages; whole-plant; dry matter; chemical composition; metabolizable energy

INTRODUCTION

Cereals in Lithuania are ones of the most important agricultural plants. They cover 43–48% of all crop area and the most part of grain, about 70% is used for forage. Spring barley makes about 36% of cereal area and 32% of general grain harvest (Liberiene, 2001; Sapoliene, 2001). Spring barley still remains the main forage cereal in Lithuania. Increasing prices of energetic resources, pesticides and fertilizers induce to get a higher yield of agricultural plants using lower amount of means (Surkus et al., 1999).

The aim of the trials was to determine the optimal harvesting growth stage of spring barley used for forage.

The yield of dry matter (DM) begins to decrease at anthesis complete growth stage of spring barley (Švihra, Talapka, 1995). The optimal period for gathering cereal is considered 4 weeks after heading (Striegl, 1982) or 2–3 weeks till hard growth stage, when the yield of DM reaches maximum and begins to decrease (Petr et al., 1984). The maximum increase of DM in cereal is characteristic from heading till milk stage but the biggest yield of DM accumulates in milk-dough and dough stages of maturity (Korneva et al., 1984), thereafter it decreased slightly for the two-row cultivars (Majdoub et al., 1994). Dynamics of DM in cereal can be influenced by meteorological conditions, soil, fertilization and other factors (Repka et al., 1978). However, it depends on decrease of assimilation surface when leaves decline and on allocation and transformation of assimilation products (Švihra, Talapka, 1995; Petr, 1991; Petr et al., 1984). The general decrease of DM yield is influenced by decrease of vegetative biomass (Masauskiene et al., 1982). Growth stages of spring barley and other cereal can be theoretically divided into three groups according accumulation dynamics of harvest:

1. increase,
2. reach of maximum,
3. decrease.

Logical solution requires to decrease yield losses, i.e. to refuse the third group. Cutting cereal in milk or milk-dough stages of maturity, it would be possible to achieve that. Of course, then it would be necessary to refuse conventional harvesting of cereal for grain applying an alternative use of all over-ground biomass for forage in such stage of maturity when maximum yield of DM and metabolizable energy (ME) is reached.

MATERIALS AND METHODS

Field experiments were carried out in 1997–1999 at the Research Station (RS) of Lithuanian University of Agriculture (LUA). Agrochemical characteristic of arable soil was determined at the LUA RS using a computer system PSCCO/ISI IBM-PC 4250.

The characteristic of arable soil is shown in Table 1.

Spring barley (*Hordeum vulgare* L.) of the variety 'Roland' was grown and its preceding crop was: 1997 winter wheat (*Triticum aestivum* L.), 1998 spring barley (*Hordeum vulgare* L.) and 1999 cultural amaranth (*Amaranthus spp.* L.). The scheme of the experiments is made learning on growth stages of spring barley according to Zadoks et al. (1974):

1. Hard	92*,	91–92,	92
2. Dough	87,	85,	87
3. Late milk-early dough	77–83,	77–83,	77–83
4. Medium milk	75,	73–75,	73
5. Early milk	71–73,	69–71,	69–71
6. Heading	57–59,	55,	57–59
7. Stem elongation	39–41,	37–39,	31

Note: * – Decimal code for the growth stages of cereal in 1997, 1998 and 1999 accordingly

In stem elongation, heading, early milk, medium milk and late milk-early dough growth stages of maturity spring barley was harvested by frontal reaper and in dough and hard stages – by combine harvester. Brutto area of each plot was 96 m^{-2} (4 x 24 m) and netto area – 66 m^{-2} (3 x 22 m). The field experiment was carried out in four replications.

Laboratory analyses of spring barley whole-plant biomass were carried out at the Tempus laboratory of agronomic and zootechnical researches at LUA using methods of Hohenheim University. Amounts of dry matter, crude protein, crude fat, crude fibre, crude ash (Naumann et al., 1993) and metabolizable energy for ruminants (cows) in MJ kg^{-1} of dry matter (Naumann et al., 1988) were determined at each harvesting growth stage in prepared samples for analyses. Drying plant samples at 103 °C for 4 hours, there was established the amount of dry matter and burning at 550 °C for 3.5 hours in muffle-furnace, there was established the amount of crude ash. Crude protein was established by the Kjeldahl method and crude fat by direct extraction with petrolether for 6 hours in Sokslet device. The concentration of crude fibre was established by plant samples boiling with

Table 1. Agrochemical indication of arable soil (0–25 cm layer)

Year	Humus %	pH_{KCl}	P	K
			mg kg^{-1} of soil	
1997	2.35	7.22	109.67	77.71
1998	2.22	7.25	106.92	91.74
1999	2.45	7.08	109.36	84.54

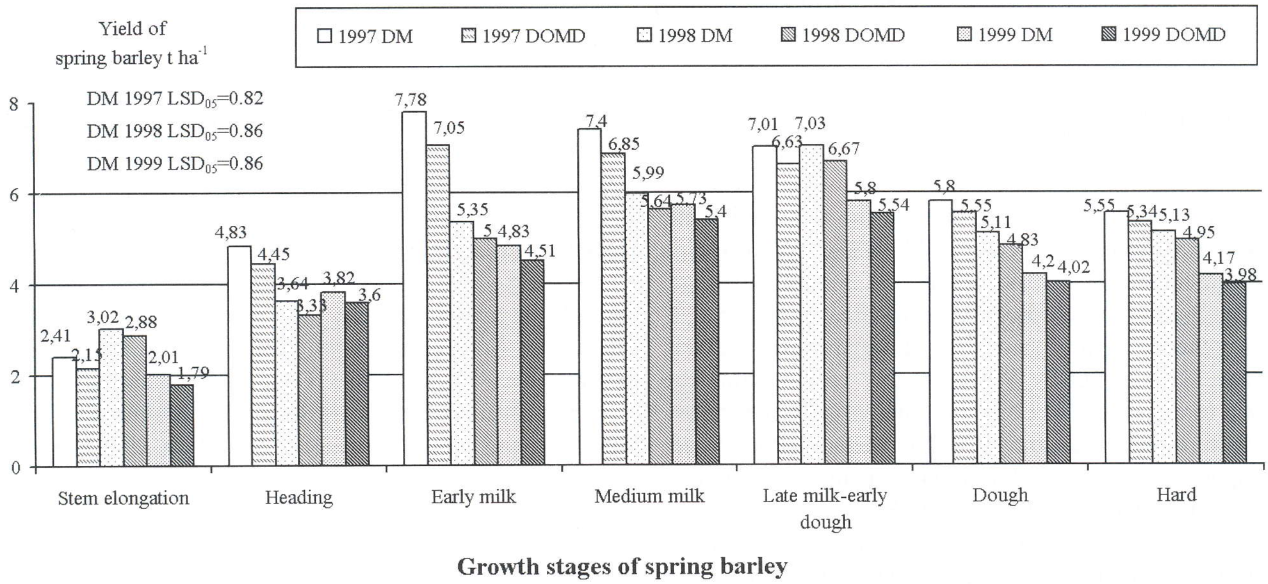

Fig. 1. Effect of growth stage at harvesting on the yield (t ha^{-1}) of DM and DOMD of spring barley, 1997–1999

DM – dry matter, DOMD – digestible organic matter in the dry matter, LSD_{05} – the least significant difference

Table 2. Effect of growth stage at harvesting on chemical composition (%) and yield (t ha^{-1}) of spring barley, 1997–1999

Growth stage	In dry matter							
	crude protein		crude fibre		crude fat		crude ash	
	%	t ha^{-1}	%	t ha^{-1}	%	t ha^{-1}	%	t ha^{-1}
1	2	3	4	5	6	7	8	9
1997								
Stem elongation	12.98	0.31	27.32	0.66	2.42	0.06	10.76	0.26
Heading	9.60	0.46	32.13	1.55	1.69	0.08	7.99	0.39
Early milk	6.61	0.51	31.61	2.45	2.30	0.18	9.46	0.74
Medium milk	7.16	0.53	28.44	2.10	2.20	0.16	7.40	0.55
Late milk-early dough	7.71	0.54	25.27	1.77	2.11	0.15	5.34	0.37
Dough	–	0.32#	–	1.64#	–	0.12#	–	0.25#
– Grain	7.91	0.186	6.42	0.15	2.37	0.06	2.63	0.06
– Straw	3.94	0.136	43.31	1.49	1.81	0.06	5.86	0.19
Hard	–	0.31#	–	1.62#	–	0.10#	–	0.21#
– Grain	8.55	0.213	6.69	0.17	2.63	0.06	2.46	0.06
– Straw	3.07	0.094	47.48	1.45	1.23	0.04	4.91	0.15
LSD_{05}		0.05		0.28		0.02		0.06
1998								
Stem elongation	16.60	0.50	28.57	0.86	1.74	0.05	11.30	0.34
Heading	9.66	0.35	28.90	1.05	2.73	0.10	8.49	0.31
Early milk	8.70	0.47	26.68	1.43	2.33	0.12	6.64	0.36
Medium milk	8.23	0.49	25.84	1.55	2.04	0.12	6.01	0.36
Late milk-early dough	6.88	0.48	22.10	1.55	2.39	0.17	5.21	0.37
Dough	–	0.32#	–	1.37#	–	0.09#	–	0.28#
– Grain	9.20	0.20	5.32	0.116	2.65	0.058	2.89	0.06
– Straw	4.04	0.12	42.85	1.251	1.25	0.036	7.54	0.22
Hard	–	0.39#	–	1.17#	–	0.10#	–	0.18#
– Grain	10.54	0.30	5.08	0.146	2.75	0.08	2.47	0.07
– Straw	3.85	0.09	45.73	1.028	1.03	0.02	5.05	0.11
LSD_{05}		0.05		0.24		0.02		0.05
1999								
Stem elongation	14.26	0.29	23.93	0.48	2.31	0.05	10.97	0.22
Heading	9.95	0.38	28.44	1.09	2.18	0.08	6.04	0.23
Early milk	7.60	0.37	21.70	1.05	2.16	0.10	6.75	0.33
Medium milk	7.98	0.46	25.05	1.43	2.64	0.15	5.87	0.34
Late milk-early dough	7.13	0.41	23.17	1.34	2.18	0.13	4.38	0.25
Dough	–	0.33#	–	1.00#	–	0.10#	–	0.19#
– Grain	11.59	0.25	5.56	0.12	3.15	0.07	2.70	0.06
– Straw	3.60	0.07	43.42	0.88	1.51	0.03	6.70	0.13
Hard	–	0.34#	–	0.93#	–	0.09#	–	0.19#
– Grain	11.93	0.27	5.79	0.13	2.89	0.07	2.89	0.06
– Straw	3.78	0.07	42.48	0.79	1.45	0.03	6.84	0.13
LSD_{05}		0.07		0.21		0.02		0.06

LSD_{05} – the least significant difference, # – total yield (grain + straw)

adequate concentration of sulphuric acid and potassium alkali, filtered, separated, washed, dried, weighed and burned at 500 °C for 3 hours in muffle-furnace (Naumann et al., 1993). Metabolizable energy (MJ kg^{-1} DM] of fodder for ruminants (cows) was established depending on gas production (CO_2 and CH_4) *in vitro* and fodder chemical composition, by the Hohenheim fodder value test. 200 mg of fodder sample with cow rumen fluid, micro- and macro-elements, buffer- and reduction-solutions is placed in the special test-tube and incubated

Table 3. Crude protein, crude fibre, crude fat and crude ash depending on dry matter yield of spring barley, 1997–1999

Indicators	Year	Linear regression equation	r	P
Crude protein	1997	$Y = 0.17258 + 0.04352\ X$	0.736^{***}	< 0.0001
	1998	$Y = 0.34131 + 0.01746\ X$	0.317^{NS}	0.1006
	1999	$Y = 0.17435 + 0.04441\ X$	0.858^{***}	< 0.0001
Crude fibre	1997	$Y = -0.2972 + 0.29454\ X$	0.964^{***}	< 0.0001
	1998	$Y = 0.30659 + 0.19391\ X$	0.937^{***}	< 0.0001
	1999	$Y = 0.0368 + 0.23097\ X$	0.961^{***}	< 0.0001
Crude fat	1997	$Y = -0.00734 + 0.02211\ X$	0.960^{***}	< 0.0001
	1998	$Y = -0.01067 + 0.02367\ X$	0.911^{***}	< 0.0001
	1999	$Y = -0.0072 + 0.02456\ X$	0.957^{***}	< 0.0001
Crude ash	1997	$Y = -0.00189 + 0.06813\ X$	0.689^{***}	< 0.0001
	1998	$Y = 0.22986 + 0.01669\ X$	0.335^{NS}	0.0817
	1999	$Y = 0.11155 + 0.03172\ X$	0.646^{***}	0.0002

^{NS} $P > 0.05$, *** $P < 0.001$

Table 4. Effect of growth stage at harvesting on ME of spring barley, 1997–1999

Growth stages	ME, MJ kg^{-1} DM			ME, GJ ha^{-1}		
	1997	1998	1999	1997	1998	1999
Stem elongation	10.80	9.24	9.97	26.03	27.91	20.04
Heading	10.00	9.02	8.61	48.30	32.83	32.89
Early milk	8.38	9.54	8.01	65.20	51.04	38.69
Medium milk	8.49	9.45	8.56	62.74	56.61	49.05
Late milk-early dough	8.60	9.67	8.64	60.29	67.98	50.11
Dough	–	–	–	51.76#	42.18#	38.94#
– Grain	11.97	11.30	11.84	28.13	24.75	25.93
– Straw	6.85	5.97	6.47	23.63	17.43	13.01
Hard	–	–	–	50.69#	46.80#	36.02#
– Grain	12.44	12.50	11.01	30.98	36.00	25.32
– Straw	6.44	4.80	5.72	19.71	10.80	10.70
LSD_{05}				6.78	7.66	7.70

ME – metabolizable energy, # – total yield (grain + straw)

Table 5. Metabolizable energy (GJ ha^{-1}) depending on crude protein, crude fibre, crude fat and crude ash of spring barley yield (t ha^{-1}), 1997–1999

Indicators	Year	Linear Regression equation	r	P
Crude protein	1997	$Y = 12.86225 + 92.216\ X$	0.750^{***}	< 0.0001
	1998	$Y = 13.74422 + 76.25057\ X$	0.420^{*}	0.0260
	1999	$Y = -10.02391 + 130.27833\ X$	0.844^{***}	< 0.0001
Crude fibre	1997	$Y = 13.3335 + 23.02355\ X$	0.967^{***}	< 0.0001
	1998	$Y = -9.35756 + 43.49977\ X$	0.900^{***}	< 0.0001
	1999	$Y = 5.01309 + 31.51516\ X$	0.948^{***}	< 0.0001
Crude fat	1997	$Y = 16.66869 + 292.22259\ X$	0.926^{***}	< 0.0001
	1998	$Y = 7.56094 + 358.44202\ X$	0.931^{***}	< 0.0001
	1999	$Y = 8.27159 + 296.74839\ X$	0.953^{***}	< 0.0001
Crude ash	1997	$Y = 32.66643 + 49.33273\ X$	0.671^{***}	< 0.0001
	1998	$Y = 22.21026 + 77.30179\ X$	0.385^{*}	0.0429
	1999	$Y = 14.54084 + 93.62236\ X$	0.576^{**}	0.0014

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$

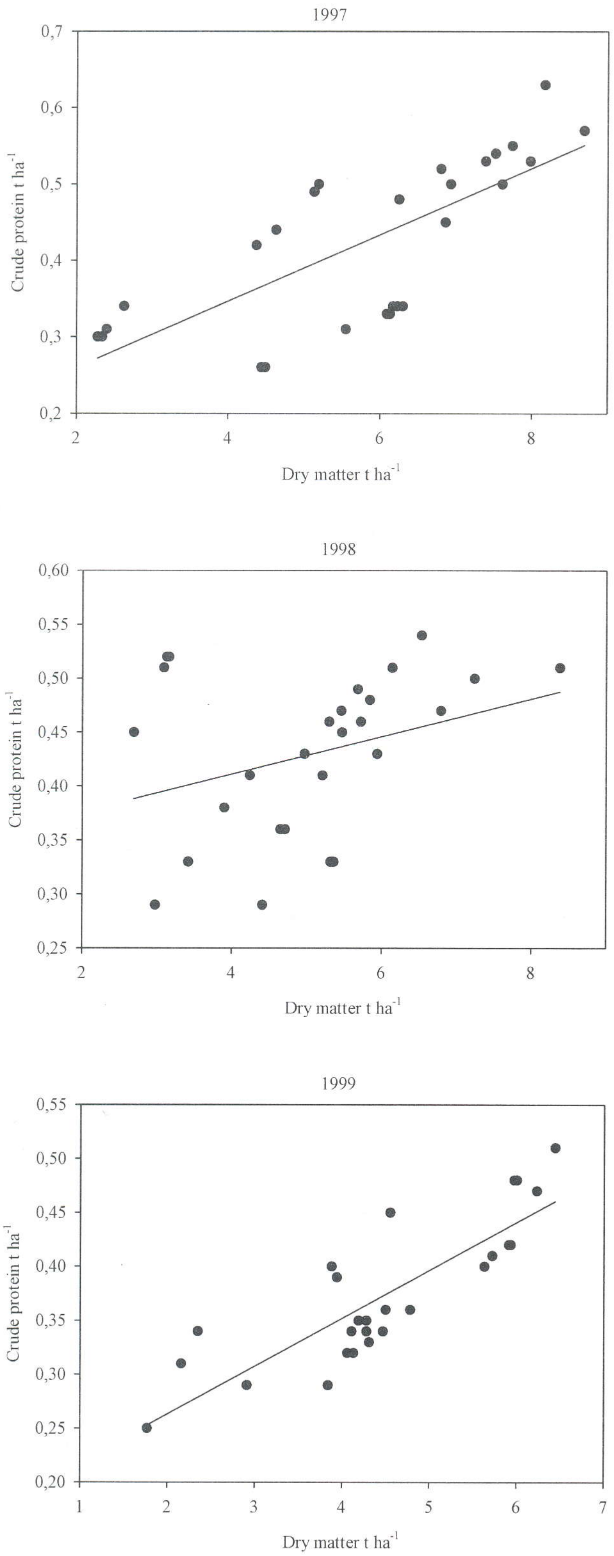

Fig. 2. Crude protein (t ha^{-1}) depending on spring barley dry matter yield (t ha^{-1}), 1997-1999

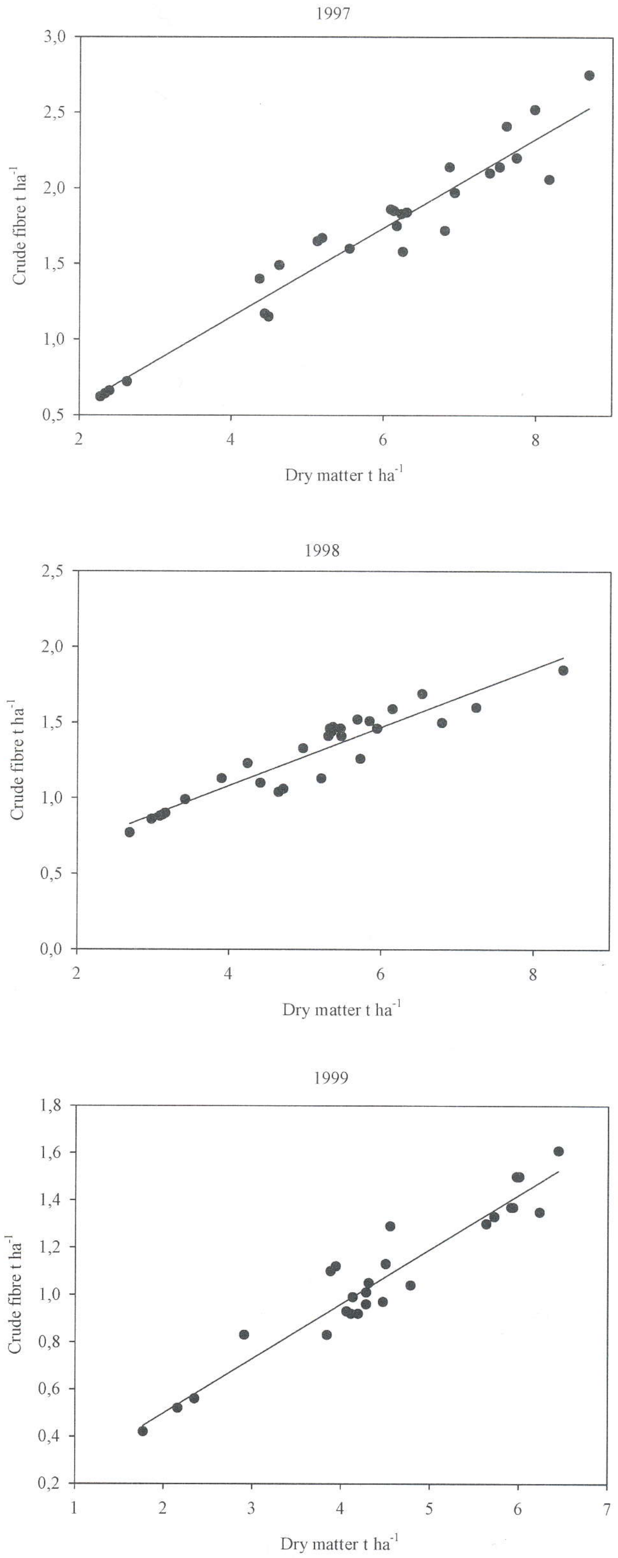

Fig. 3. Crude fibre (t ha^{-1}) depending on spring barley dry matter yield (t ha^{-1}), 1997–1999

in a rotory thermostat by 39 °C for 24 hours (N a u m a n n et al., 1988).

The quality of the laboratory researches data was determined leaning on differences between the parallels of the research depending on concentration of materials in analysing sample. If the differences exceeded limited errors, the analyses were carried out anew. The results are statistically reliable of 95% level of probability (N a u m a n n et al., 1993).

The experiment data were evaluated by the statistical methods of Anova and correlation-regression analysis being 95%, 99% and 99.9% levels of probability.

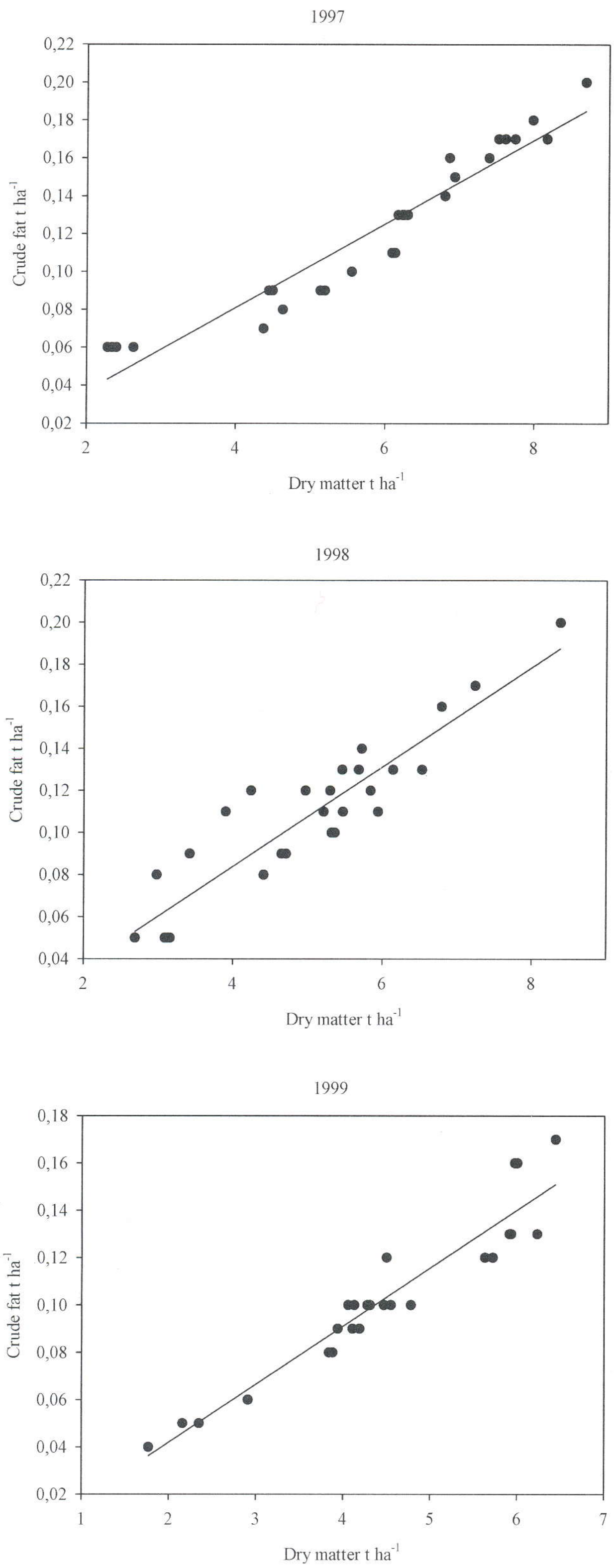

Fig. 4. Crude fat (t ha^{-1}) depending on spring barley dry matter yield (t ha^{-1}), 1997–1999

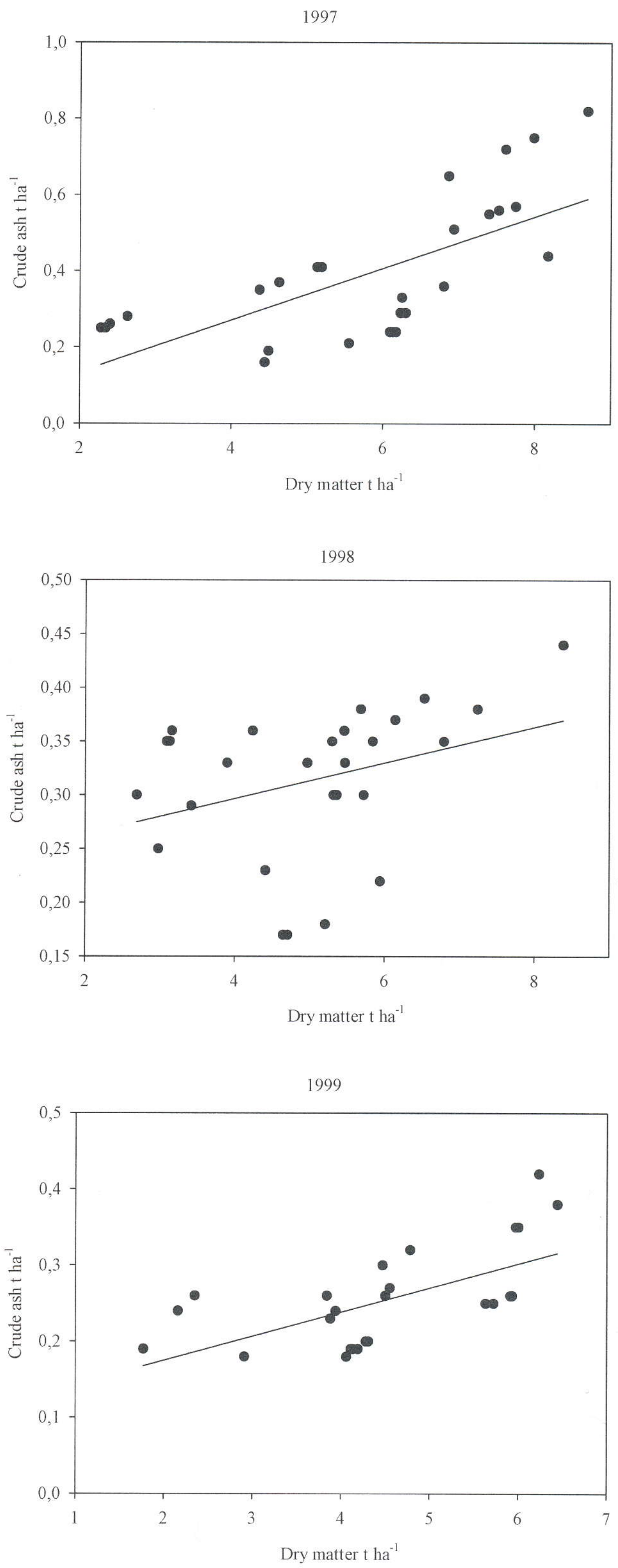

Fig. 5. Crude ash (t ha^{-1}) depending on spring barley dry matter yield (t ha^{-1}), 1997–1999

RESULTS AND DISCUSSION

The yield of dry matter (DM) and of digestible organic matter in the dry matter (DOMD) of the spring barley at each of the seven harvesting dates during three years of experiment is given in Fig. 1. The DM the same as DOMD yield increased significantly as the spring barley matured from stem elongation to late milk-early dough growth stages. In the further growth stages of spring barley – dough and hard – DM and DOMD yield decreased significantly.

The chemical composition of the spring barley is shown in Table 2. The concentration of crude protein (CP), crude fibre, crude fat and crude ash (CA) variation

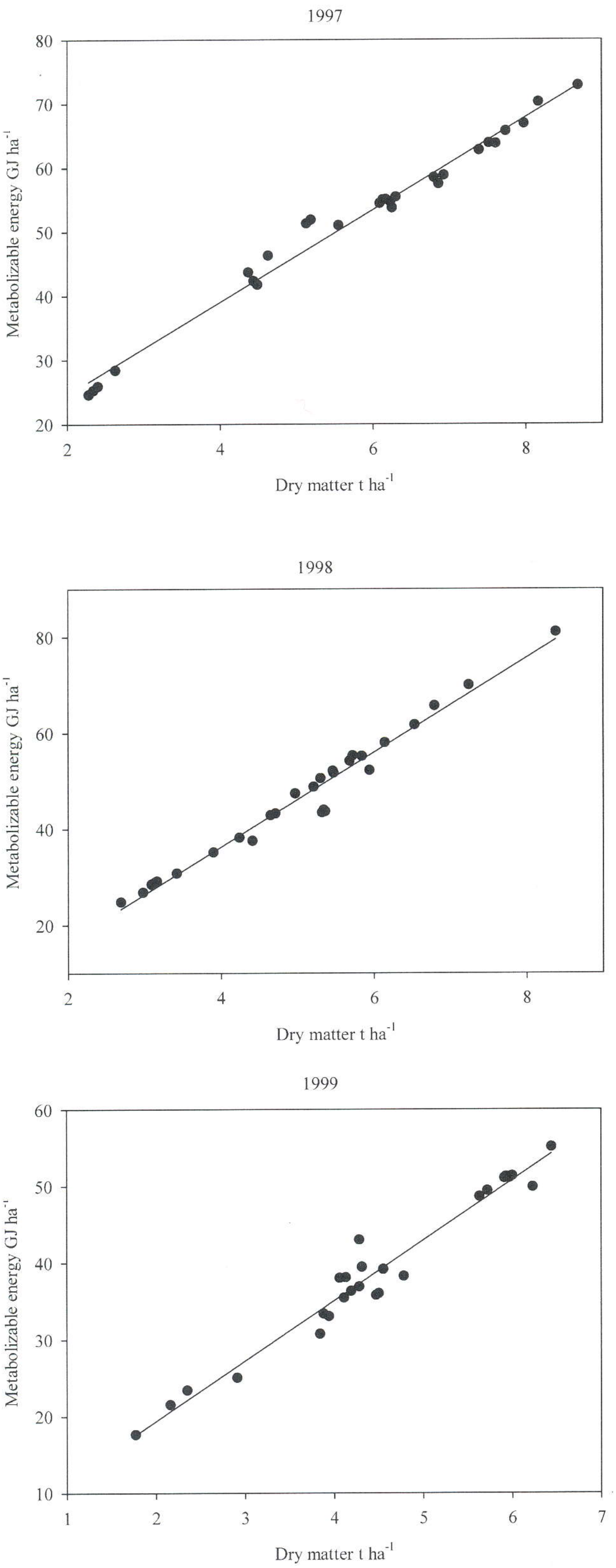

Fig. 6. Metabolizable energy (GJ ha^{-1}) depending on dry matter yield of spring barley (t ha^{-1}), 1997–1999

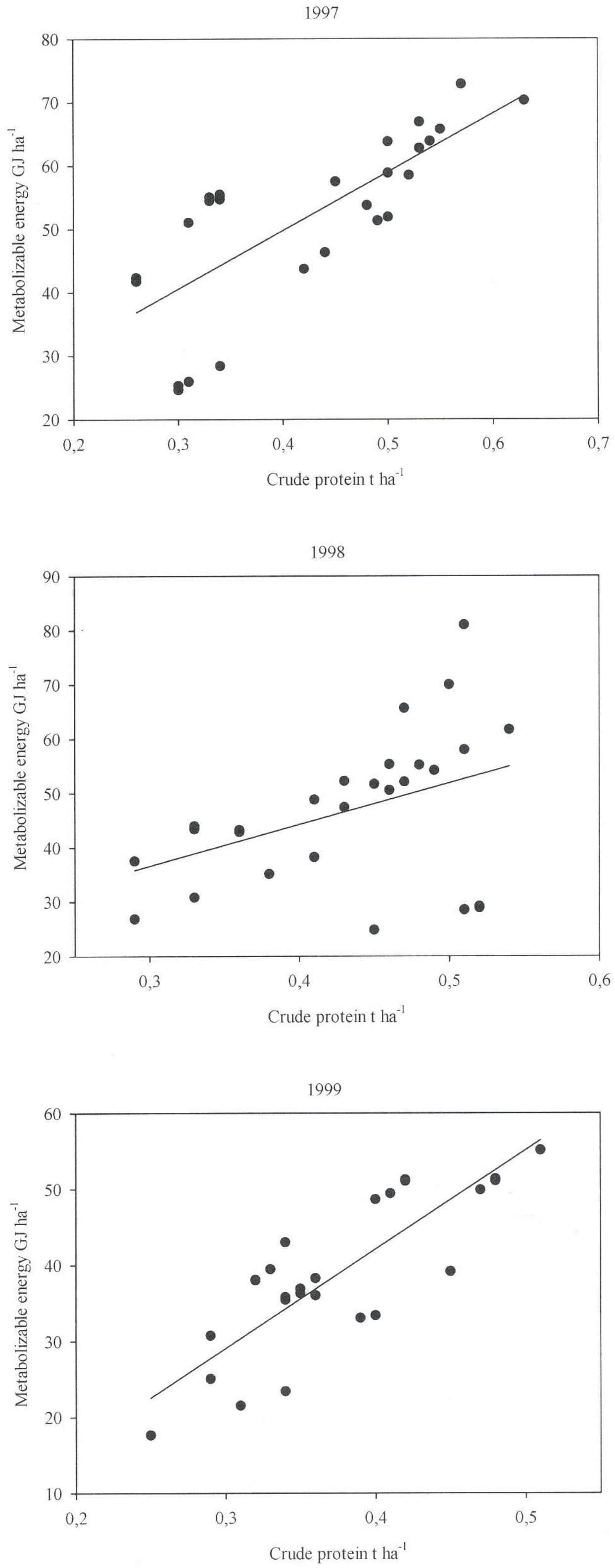

Fig. 7. Metabolizable energy (GJ ha^{-1}) depending on crude protein yield (t ha^{-1}), 1997–1999

of each year of the experiment preserved analogical tendency. The concentration of CP and CA was observed the biggest at the stem elongation growth stage and as the spring barley matured the concentration of CP and CA decreased. However, in the grain-dough and hard growth stages-concentration of these chemical components increased but in the straw it decreased. Therefore, yield of CP and CA decreased significantly in dough and hard growth stages compared with early milk, medium milk and late milk-early dough stages of spring barley maturity. The concentration of crude fibre and crude fat tended to increase or decrease as the spring barley ma-

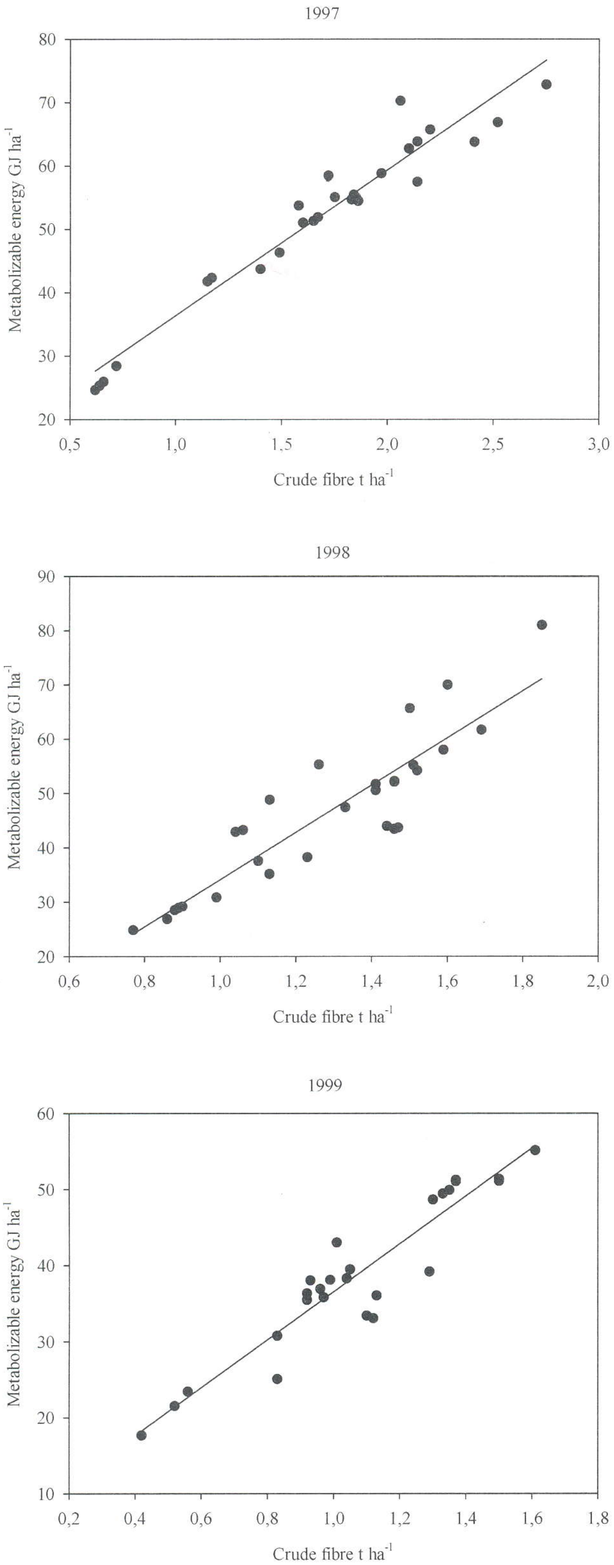

Fig. 8. Metabolizable energy (GJ ha^{-1}) depending on crude fibre yield (t ha^{-1}), 1997–1999

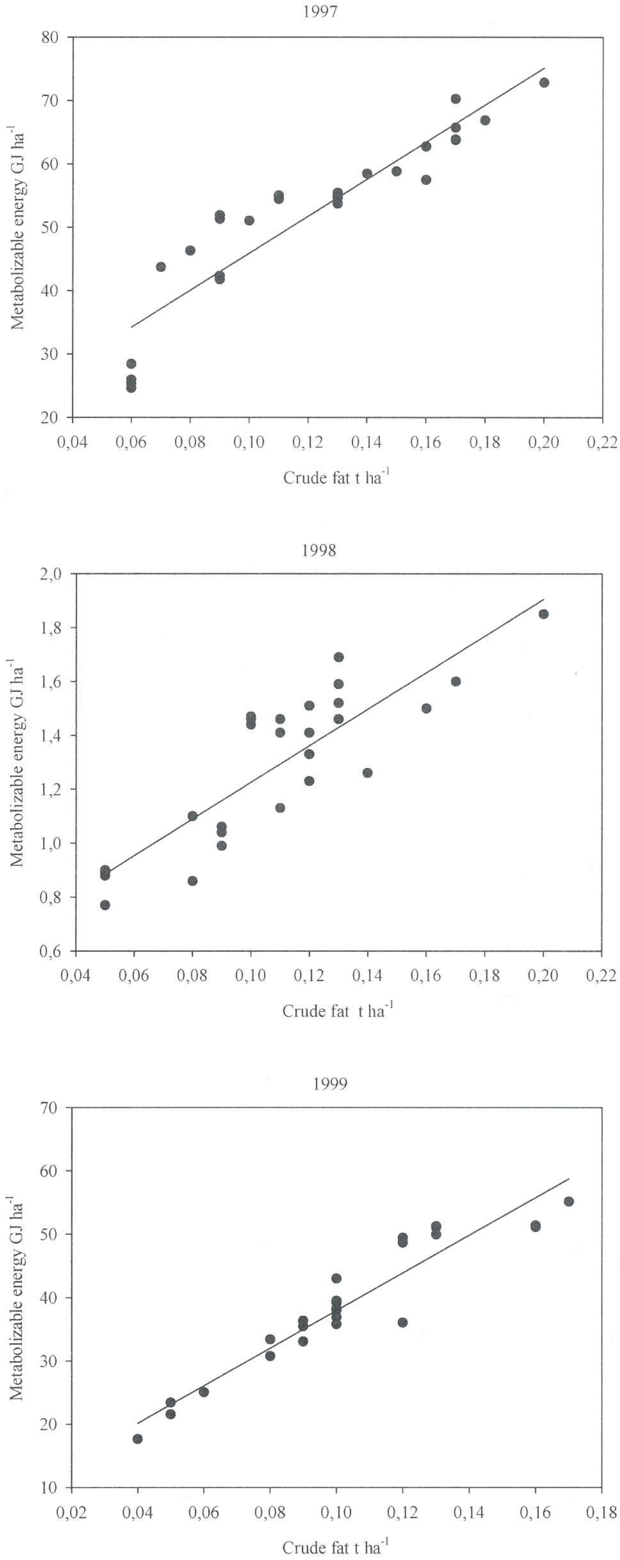

Fig. 9. Metabolizable energy (GJ ha^{-1}) depending on crude fat yield (t ha^{-1}), 1997–1999

tured. However, the yield of crude fibre and crude fat in dough and hard growth stages decreased significantly.

The yield of CP, crude fibre, crude fat and CA depended highly significantly on DM accumulation dynamics of spring barley. Confidential linear relationships were determined (Figs 2–5 and Table 3).

Using cereal as the whole-plant for forage, it is important not only higher yield but also the quality of it which depends on the intake, too. The metabolizable energy (ME) in spring barley yield for ruminants (cows) is given in Table 4. Metabolizable energy is energy intaken directly and used in animal's organism.

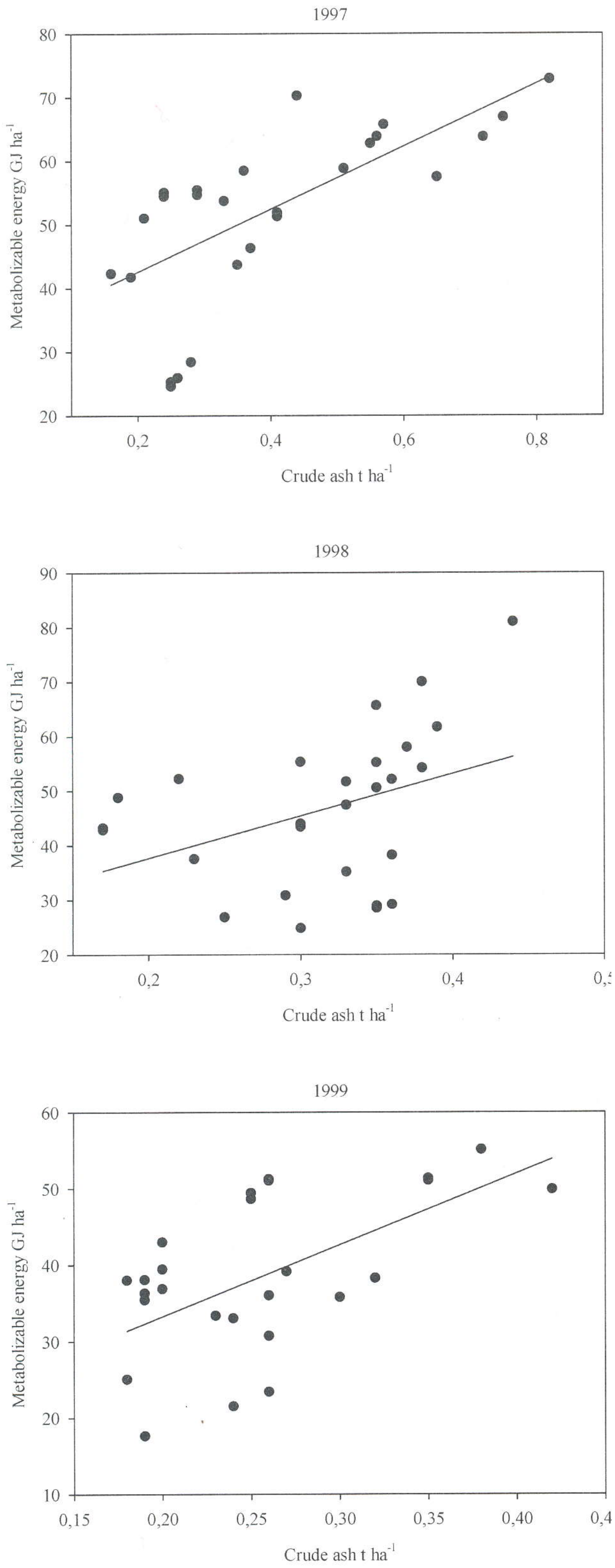

Fig. 10. Metabolizable energy (GJ ha^{-1}) depending on crude ash yield (t ha^{-1}), 1997–1999

Brutto forage energetic losses are rejected beforehand, which are experienced in animal's organism for various reasons (energetic losses with faeces, urine and intestine gas and energy necessary for digestion process) (Mikulioniene, Stankevicius, 2003; Naumann et al., 1993).

The ME (MJ kg^{-1} DM) was similar to the chemical composition dynamics. In contrast to the ME content (MJ kg^{-1} DM), the amount of ME from hectare increased significantly as the spring barley matured till the late milk-early dough growth stage, and likewise, DM, DOMD, CP and CA yield decreased significantly in dough and hard growth stages. When spring barley grain matures in hard growth stage compared with dough stage, the yield of DM, CP, crude fibre and ME increases. The yield of crude fat and CA almost does not differ. However, when the quality of straw becomes worse, the general value of yield remains fewer than in milk-dough stage. Martin and Seibold (1997) determined comparable results: ME of 9.56 MJ kg^{-1} DM at heading stage of maturity and ME of grain 12.93 MJ kg^{-1} DM and 6.80 MJ kg^{-1} DM of straw at hard stage of spring barley maturity.

The relationship between the amount of ME (GJ ha^{-1}) and DM yield is shown in correlation-regression analysis in Fig. 6. The ME (GJ ha^{-1}) strongly depended on DM yield (t ha^{-1}) during all three years of the experiment. The linear regression equations fit for those relationships best: 1997 – $y = 10.13068 + 7.21367\ X$ ($r = 0.992^{***}$, $P < 0.0001$); 1998 – $y = -3.17818 + 9.85581\ X$ ($r = 0.985^{***}$, $P < 0.0001$); 1999 – $y = 3.66508 + 7.85369\ X$ ($r = 0.983^{***}$, $P < 0.0001$). Each year of the experiment, one ton of spring barley whole-plant DM increased ME on 7.21 GJ ha^{-1} in 1997, 9.86 GJ ha^{-1} in 1998 and 7.85 GJ ha^{-1} in 1999. Likewise, there was statistically reliable dependence of ME (GJ ha^{-1}) on CP, crude fibre, crude fat and CA (Figs 7–10 and Table 5).

So, earlier harvesting of spring barley in milk or late milk-early dough growth stages is an effective means to increase DM and ME yields.

Likewise, as in our experiment, the biggest concentration of nutrition in stem elongation growth stage of spring barley and other cereal was determined. The concentration of nutrition essentially decreased till minimum at the end of vegetation (Baier, 1986) and remained constant near maturity (Ayub et al., 1999; Majdoub et al., 1994). At the end of cereal vegetation, growth of DM is zero and biological yield does not increase but even begins to decrease (Kupka et al., 1977). Losses of DM in spring barley yield can be decreased additionally using nitrogen. However, spring barley loses a part of whole-plant DM yield before reaching hard stage in variables of the trials fertilized and non-fertilized by nitrogen (Pettersson, 1989). That is because of index of green plant surface area decreases till zero when respiration occurs in plant ears, which requires energy. So, if photosynthesis does not occure, spring barley matures about 3 weeks till harvesting using non-replenished energetic resources. Moreover, development of DM in plant organs fully influences not only the product (grain) but also the growth of a plant and biological yield.

Usually the differences between agricultural plants and their varieties are seen in differences of speed usage of DM of assimilation tissues. In some cases, when general biomass of cereal increases, grain yield does not increase because of the development of some assimilation products in vegetative organs (Petr et al., 1984).

CONCLUSIONS

1. The DM, its main components and ME increase as the spring barley matures which maximum is reached at early milk, medium milk and late milk-early dough growth stages. At dough and hard stages all yields significantly decrease.
2. ME correlated positively with DM and its components: CP, crude fibre, crude fat and CA of spring barley.
3. Regarding the farming, it is more effective to use forage made of whole-plant for feeding animals which intake more ME than from separately used grain and straw.

Acknowledgment

We would like to thank Mrs. Vilma Pilipaviciene for her help in English paper corrections.

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Received for publication on September 14, 2003
Accepted for publication on December 16, 2003

PILIPAVIČIUS, V. (Lithuanian University of Agriculture, Faculty of Agronomy, Kaunas district, Lithuania):

Vliv stadia růstu při sklizni na výnos, chemické složení a obsah metabolizovatelné energie u jarního ječmene.

Scientia Agric. Bohem., *35*, 2004: 41–51.

Polní a laboratorní pokusy se prováděly v letech 1997 až 1999 na Litevské zemědělské univerzitě. Cílem těchto pokusů bylo zjistit dynamiku akumulace sušiny a stravitelných organických látek v sušině, chemické složení sušiny a využitelnou energii pro přežvýkavce (krávy) v závislosti na stadiu růstu a určit optimální stadium růstu pro sklizeň jarního ječmene.

Rostliny odrůdy jarního ječmene Roland se sklízely ve stadiu prodlužování, metání, rané mléčné, střední mléčné a pozdní mléčné zralosti a ve stadiích rané voskové a voskové zralosti obilek. V průběhu růstu a rozvoje rostliny jarního ječmene postupně akumulují sušinu a využitelnou energii, která dosahuje nejvyšší hodnoty ve stadiu střední mléčné a pozdní mléčné zralosti a rané voskové zralosti. V dalších stadiích zralosti klesá výnos sušiny a množství využitelné energie. Nejvyššího výnosu sušiny jarního ječmene bylo dosaženo ve stupni rané mléčné zralosti (1997) – 7,78 t ha^{-1}, ve stadiu pozdní mléčné zralosti a rané voskové zralosti (1998, 1999) – 7,03 t ha^{-1}, resp. 5,80 t ha^{-1}. Během sklizně jarního ječmene ve stadiu voskové zralosti poklesl výnos sušiny na 5,55 t ha^{-1} v roce 1997, 5,13 t ha^{-1} v roce 1998 a 4,17 t ha^{-1} v roce 1999 (obr. 1), tj. na 40 %, 37 % a 39 %. Nejvyšší hodnoty využitelné energie bylo dosaženo analogicky s tvorbou sušiny – ve stadiu rané mléčné zralosti (1997), tj. 65,2 Gj ha^{-1}, v pozdním stadiu mléčné zralosti a raném stadiu voskové zralosti (1998 a 1999), tj. 68,0 Gj ha^{-1}, resp. 50,1 Gj ha^{-1}. Během sklizně jarního ječmene ve stadiu voskové zralosti poklesla hodnota využitelné energie na 50,7 Gj ha^{-1} (v roce 1997), 46,8 Gj ha^{-1} (v roce 1998) a na 36,0 Gj ha^{-1} (v roce 1999) (tab. 4.), tj. na 29 %, 45 % a 39 %.

Byla zjištěna pozitivní, statisticky významná lineární závislost hrubých bílkovin jarního ječmene (t ha^{-1}) $r_{1997} = 0{,}736^{***}$, $r_{1998} = 0{,}317$, $r_{1999} = 0{,}858^{***}$, hrubé vlákniny (t ha^{-1}) $r_{1997} = 0{,}964^{***}$, $r_{1998} = 0{,}937^{***}$, $r_{1999} = 0{,}961^{***}$, hrubého tuku (t ha^{-1}) $r_{1997} = 0{,}960^{***}$, $r_{1998} = 0{,}911^{***}$, $r_{1999} = 0{,}957^{***}$ a hrubého popele (t ha^{-1}) $r_{1997} = 0{,}689^{***}$, $r_{1998} = 0{,}335$, $r_{1999} = 0{,}646^{***}$ na výnosu sušiny (t ha^{-1}) (tab. 3, obr. 2, 3, 4, 5) a lineární závislost využitelné energie (Gj ha^{-1}) na sušině jarního ječmene (t ha^{-1}), $r_{1997} = 0{,}992^{***}$, $r_{1998} = 0{,}985^{***}$, $r_{1999} = 0{,}983^{***}$, hrubých bílkovin (t ha^{-1}) $r_{1997} = 0{,}750^{***}$, $r_{1998} = 0{,}420^{*}$, $r_{1999} = 0{,}844^{***}$, hrubé vlákniny (t ha^{-1}) $r_{1997} = 0{,}967^{***}$, $r_{1998} = 0{,}900^{***}$, $r_{1999} = 0{,}948^{***}$, hrubého tuku (t ha^{-1}) $r_{1997} = 0{,}926^{***}$, $r_{1998} = 0{,}931^{***}$, $r_{1999} = 0{,}953^{***}$ a na výnosu hrubého popele (t ha^{-1}) $r_{1997} = 0{,}671^{***}$, $r_{1998} = 0{,}385^{*}$, $r_{1999} = 0{,}576^{**}$ (tab. 5, obr. 6, 7, 8, 9, 10).

Když dozrají obilky jarního ječmene ve stadiu růstu mléčné zralosti ve srovnání se stadiem voskové zralosti, výnos sušiny, hrubých bílkovin, hrubé vlákniny a využitelné energie se zvyšuje. Výnos hrubého tuku a hrubého popele se téměř neliší. Když se však zhoršuje kvalita slámy, celková hodnota výnosu zůstává nižší ve stadiu mléčné zralosti.

Podle výsledků tříletých pokusů se jarní ječmen na siláž může sklízet ve stadiu rané mléčné, střední nebo pozdní mléčné voskové zralosti, kdy jsou dosahovány nejvyšší hodnoty výnosů sušiny, jejích složek a využitelné energie.

jarní ječmen; stadia růstu; celá rostlina; sušina; chemické složení; využitelná energie

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