Effect of some factors on growth of lambs from crossing between the Improved Wallachian and East Friesian

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ABSTRACT: The effect of some factors (genotype, sex, litter size, age of dam at lambing, month of lambing and year of birth of lamb) on the growth of lambs – crossbreds between the Improved Wallachian (IW) and East Friesian (EF) breed was evaluated in operating conditions during two successive years. Three genotypes were evaluated: IW 50 EF 50, EF 75 IW 25 and EF 87.5 IW 12.5. The evaluation of the effect of genotype on growth showed that this factor did not have a significant effect on the majority of growth traits under study. In the period from birth to 100 days of age the highest daily gain was found in IW 50 EF 50 (263 g). The daily gains of EF 75 IW 25 and EF 87.5 IW 12.5 in this period were lower but identical (244 g). Age of dam had a significant effect on the majority of growth traits under study. Sex of lamb had a significant effect on body weight at 100 days of age and also on the majority of daily gains under study. The factors litter size, month of lambing and year of lamb birth were the most significant sources of variation of daily gains. As far as the non-genetic factors were concerned, the highest daily gains from birth to 100 days of age were recorded in males (259 g), in singles (260 g), in lambs from 4-years-old ewes (269 g), in lambs born in January (263 g) and in lambs born in the first year of evaluation (256 g). The analysis of phenotypic correlations indicated that body weight at birth showed a positive and highly significant ($P \le 0.01$) effect on the majority of growth traits under study. All phenotypic correlations between individual body weights were positive and high ($P \le 0.01$). The majority of phenotypic correlations between individual daily gains under study were also positive and high ($P \le 0.01$).

Keywords: lamb; growth traits; Improved Wallachian; East Friesian

Improved Wallachian is a typical sheep breed in the Czech Republic and, at present, this breed accounts for approximately 4% of the domestic sheep population (Holá, 2004). Improved Wallachian is generally a triple-purpose breed producing meat, milk and wool. In the Czech Republic this breed is reared above all for production of lambs and there are only a few farms where the ewes of this breed are milked. However, production of lambs is an important source of income also on these farms and the revenues from the sale of this commodity amount to approximately 25–35% of total incomes. Improved Wallachian (IW) sheep are very resistant to unfavourable climatic conditions and for that reason they are very suitable for raising in submontane and mountain regions. Their milk efficiency per lactation and prolificacy range from 120 to 140 l and 140–150%, resp. The average daily gains of lambs from birth to 100 days of age range from 220 to 250 g (Horák et al., 2004). In the majority of domestic farms, IW sheep are raised as purebreds. On the other hand, commercial or absorption crossing with East Friesian (EF) rams started several years ago, above all on milk producing farms. The main aims of these crossings are to improve milk efficiency and growth parameters of lambs. According to Horák et al. (2004), the prolificacy of East Friesian breed, milk efficiency per

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lactation and daily gain from birth to 100 days of age range from 170 to 200%, 250 to 300 l and 250 to 300 g, resp.

The growth of lambs is influenced by a great number of different factors while nutrition, health condition and genotype belong to the most important ones. Other factors that can influence the growth ability of lambs to a greater or lesser extent are for example sex, litter size, month or season of lambing, age of dam and year of lamb birth. In the 1980's several studies (Macháček et al., 1981; Křížek et al., 1981, 1982) were published in the Czech Republic that investigated the growth of lambs originating from crossing with East Friesian rams. However, the growth of lambs originating from crossing between the Improved Wallachian and East Friesian breed was not analysed in any of the above-mentioned studies.

Considering this fact and also a continuously increasing interest of breeders in the use of EF rams in the framework of commercial or absorption crossing with ewes of IW breed the main aim of our study was to evaluate effect of some factors (genotype, sex, litter size, age of dam at lambing, month of lambing and year of lamb birth) on the growth of lambs from crossing between the Improved Wallachian and East Friesian breed.

MATERIAL AND METHODS

The effect of some factors (genotype, sex, litter size, age of ewe at lambing, month of lambing and year of lamb birth) on the growth of lambs from crossing between the Improved Wallachian and East Friesian breed was evaluated in operating conditions on a sheep farm in Valašská Bystřice. Within the evaluation of the effect of genotype on growth these genotypes were investigated: IW 50 EF 50, EF 75 IW 25 and EF 87.5 IW 12.5. The study was performed in a period of two successive years and involved altogether 156 lambs originating from 99 dams. Natural mating of ewes with two rams (harem system) was used during the whole study period. In both years of evaluation all lambs were born in the period from January to February. After lambing, all lambs were reared in a standard manner till the end of the study period, i.e. with their mothers in a stable with deep litter. At the end of the evaluation, i.e. when the average age of lambs was 100 days, the majority of lambs were sold to a slaughterhouse and all dams began to be milked.

In both years, the feeding ration of lambs was based on the intake of mother milk (*ad libitum*). Their feeding ration further consisted of meadow hay (*ad libitum*), mineral lick (*ad libitum*) and concentrate supplement ČOT (concentrate supplement for an early weaning of calves, PDI-E 105 g/kg, NEF 7.8 MJ/kg). The average daily consumption of ČOT per lamb was 0.15 kg. In both years, the feeding ration of dams consisted of meadow hay, concentrate supplement ČOT and mineral lick. Health condition and nutritional status of dams and their lambs were good during the whole study period.

In both years, all lambs were weighed for the first time at birth (BW 0) and thereafter regularly in two-week intervals. All determinations of weight were carried out to the nearest 0.1 kg. On the basis of the results of weighing the body weight (BW) was adjusted to average age 30 (BW 30), 70 (BW 70) and 100 days (BW 100) by using a linear interpolation method. Daily gains (DG) were calculated in grams (g) for the following intervals:
DG 1 = DG between (BW 0) and (BW 30)
DG 2 = DG between (BW 30) and (BW 70)
DG 3 = DG between (BW 0) and (BW 70)
DG 4 = DG between (BW 30) and (BW 100)
DG 5 = DG between (BW 70) and (BW 100)
DG 6 = DG between (BW 0) and (BW 100)

Recorded data were statistically analysed using the least-squares method (SAS; PROC GLM variant ss4). The systematic effects were genotype, sex, litter size, age of dam at lambing, month of lambing and year of lamb birth. The following model equation was used for statistical calculations:

$$Y_{ijklmn} = \mu + G_i + S_j + LS_k + A_l + M_m + YB_n + e_{ijklmn}$$

where:
Y_{ijklmn} = measured trait
μ = overall mean
G_i = effect of the i^{th} genotype (fixed effect – 3 classes)
S_j = effect of the j^{th} sex (fixed effect – 2 classes)
LS_k = effect of the k^{th} litter size (fixed effect – 3 classes)
A_l = effect of the l^{th} age of dam (fixed effect – 4 classes)
M_m = effect of the m^{th} month of lambing (fixed effect – 2 classes)
YB_n = effect of the n^{th} year of lamb birth (fixed effect – 2 classes)
e_{ijklmn} = residual error

Phenotypic correlations were calculated by Pearson's method.

Statistical analysis was carried out using the mathematical-statistical programme SAS version 8.2.

RESULTS AND DISCUSSION

Least-squares means and standard errors of body weights (BW) and daily gains (DG) according to genotype of lamb, sex, litter size, age of dam, month of lambing and year of lamb birth are presented in Tables 1 and 2. The evaluation of the effect of genotype on growth showed above all that this factor had a significant effect ($P \leq 0.05$) only on BW 100 and DG 6. On the other hand, for example Pitchford (1993), Burfening and Carpio (1995), El-Fadili et al. (2000), Suarez et al. (2000), and Margetín et al. (2004) reported that the genotype influenced the majority of growth traits significantly. In our study, the highest DG 6 and BW 100 (263 g and 29.99 kg) were found out in IW 50 EF 50. In the two remaining genotypes (EF 75 IW 25 and EF 87.5 IW 12.5) DG 6 and BW 100 were lower but relatively very uniform (244 vs. 244 g and 28.00 vs. 28.12 kg). The above-mentioned data indicate that the increasing percentage of EF blood in crossbreds did not show a significant effect on growth ability. But the higher daily gains were found out in all genotypes under study compared to those reported by Křížek et al. (1981) and Holá (2004) in purebred IW lambs.

Table 1. Least-squares means and standard errors (L.S.M. ± S.E.M) of body weights (BW in kg) according to genotype of lamb, sex, litter size, age of dam, month of lambing and year of lamb birth

	n	BW 0	BW 30	BW 70	BW 100
Genotype of lamb					
IW 50 EF (A)	55	3.66 ± 0.10	12.71 ± 0.39	21.39 ± 0.64	29.99 ± 0.77^{b}
EF 75 IW (B)	73	3.59 ± 0.09	12.14 ± 0.36	20.16 ± 0.58	28.00 ± 0.70^{a}
EF 87.5 IW (C)	28	3.76 ± 0.15	11.85 ± 0.60	20.06 ± 0.98	28.12 ± 1.18
Sex					
Male (A)	63	3.69 ± 0.10	11.85 ± 0.38	20.85 ± 0.63	29.60 ± 0.75^{b}
Female (B)	93	3.65 ± 0.09	12.62 ± 0.35	20.23 ± 0.57	27.81 ± 0.68^{a}
Litter size					
Singles (A)	40	4.15 ± 0.11^{BC}	14.18 ± 0.44^{BC}	22.59 ± 0.72^{bC}	30.15 ± 0.86^{c}
Twins (B)	94	3.50 ± 0.08^{A}	12.07 ± 0.32^{AC}	20.59 ± 0.53^{ac}	28.79 ± 0.63
Triplets (C)	22	3.36 ± 0.14^{A}	10.45 ± 0.58^{AB}	18.44 ± 0.94^{Ab}	27.17 ± 1.13^{a}
Age of dam (years)					
2 (A)	64	3.22 ± 0.10^{BCD}	11.10 ± 0.38^{bC}	18.73 ± 0.62^{bC}	26.14 ± 0.74^{BC}
3 (B)	47	3.88 ± 0.11^{A}	12.36 ± 0.43^{a}	20.80 ± 0.70^{a}	29.51 ± 0.84^{A}
4 (C)	28	3.64 ± 0.14^{A}	13.38 ± 0.56^{A}	22.05 ± 0.91^{A}	30.57 ± 1.09^{A}
5 and more (D)	17	3.95 ± 0.17^{A}	12.09 ± 0.67	20.58 ± 1.09	28.60 ± 1.31
Month of lambing					
January (A)	71	3.77 ± 0.09	12.02 ± 0.36	21.93 ± 0.59^{B}	30.05 ± 0.71^{B}
February (B)	85	3.57 ± 0.10	12.45 ± 0.39	19.14 ± 0.64^{A}	27.36 ± 0.76^{A}
Year of lamb birth					
2001 (A)	68	3.59 ± 0.11	13.54 ± 0.43^{B}	20.35 ± 0.70	29.24 ± 0.83
2002 (B)	88	3.75 ± 0.08	10.93 ± 0.34^{A}	20.72 ± 0.55	28.17 ± 0.66

$^{A,B,C,D}P \leq 0.01$; $^{a,b,c,d}P \leq 0.05$

Table 2. Least-squares means and standard errors (L.S.M. ± S.E.M.) of daily gains (DG in g) according to genotype of lamb, sex, litter size, age of dam, month of lambing and year of lamb birth

	n	DG 1	DG 2	DG 3	DG 4	DG 5	DG 6
Genotype of lamb							
IW 50 EF (A)	55	302 ± 12.51	217 ± 14.22	253 ± 8.66	247 ± 8.96	287 ± 17.50	263 ± 7.33^{b}
EF 75 IW 25 (B)	73	285 ± 11.37	201 ± 12.93	237 ± 7.87	227 ± 8.15	261 ± 15.91	244 ± 6.66^{a}
EF 87.5 IW 12.5 (C)	28	270 ± 19.12	205 ± 21.73	233 ± 13.24	233 ± 13.70	269 ± 26.75	244 ± 11.21
Sex							
Male (A)	63	272 ± 12.22^{b}	225 ± 13.89^{b}	245 ± 8.46	254 ± 8.75^{B}	292 ± 17.10^{b}	259 ± 7.16^{b}
Female (B)	93	299 ± 11.11^{a}	190 ± 12.63^{a}	237 ± 7.69	217 ± 7.96^{A}	253 ± 15.54^{a}	242 ± 6.51^{a}
Litter size							
Singles (A)	40	335 ± 14.06^{BC}	210 ± 15.98	263 ± 9.73^{C}	228 ± 10.07	252 ± 19.67	260 ± 8.24
Twins (B)	94	285 ± 10.29^{Ac}	213 ± 11.69	244 ± 7.12^{c}	239 ± 7.37	273 ± 14.39	253 ± 6.03
Triplets (C)	22	236 ± 18.32^{Ab}	200 ± 20.83	215 ± 12.68^{Ab}	239 ± 13.12	291 ± 25.64	238 ± 10.74
Age of dam (years)							
2 (A)	64	263 ± 12.06^{C}	191 ± 13.71	222 ± 8.35^{C}	215 ± 8.64^{bc}	247 ± 16.88	229 ± 7.07^{BC}
3 (B)	47	283 ± 13,61^{c}	211 ± 15.46	242 ± 9.42	245 ± 9.75^{a}	290 ± 19.04	256 ± 7.97^{A}
4 (C)	28	325 ± 17.67^{Abd}	217 ± 20.09	263 ± 12.23^{A}	245 ± 12.66^{a}	284 ± 24.72	269 ± 10.36^{A}
5 and more (D)	17	271 ± 21.33^{c}	212 ± 24.24	238 ± 14.76	236 ± 15.27	267 ± 29.83	247 ± 12.50
Month of lambing							
January (A)	71	275 ± 11.58	248 ± 13.16^{B}	259 ± 8.02^{B}	258 ± 8.30^{B}	271 ± 16.20	263 ± 6.79^{B}
February (B)	85	296 ± 12.40	167 ± 14.10^{A}	222 ± 8.59^{A}	213 ± 8.88^{A}	274 ± 17.35	238 ± 7.27^{A}
Year of lamb birth							
2001 (A)	68	332 ± 13.57^{B}	170 ± 15.42^{B}	239 ± 9.39	224 ± 9.72^{b}	296 ± 18.99^{b}	256 ± 7.95
2002 (B)	88	239 ± 10.72^{A}	245 ± 12.18^{A}	242 ± 7.42	246 ± 7.68^{a}	248 ± 15.00^{a}	244 ± 6.28

$^{A,B,C,D}P \leq 0.01$; $^{a,b,c,d}P \leq 0.05$

Sex of lamb had a significant effect on all daily gains under study except DG 3. With the exception of DG 1, higher daily gains were found in males in all cases. Similar findings were reported by Hammel and Laforest (2000), Dixit et al. (2001), Fernandes et al. (2001), Macit et al. (2001), Abegaz et al. (2002), and Matika et al. (2003). However, it is necessary to state that the above-mentioned authors recorded higher daily gains in males in all intervals under study. In males, DG 6 was significantly ($P \leq 0.05$) higher than in females (259 vs. 242 g) and the level of DG 6 in males was significantly higher than the data published by Kuchtík et al. (1997) in lambs originating from crossing between Improved Wallachian and Bergschaf. Significantly higher DG 6 of males was also reflected in their significantly higher BW 100. On the other hand, Burfening and Carpio (1993) concluded that the effect of sex on body weight was not significant at the age of 120 days.

Litter size had a significant effect on all body weights under study, and the highest body weights were recorded in singles in all cases. This is in agreement with the results by Carrillo and Segura (1993), Analla et al. (1998), Goetsh (1998), and Fernandes et al. (2001). On the other hand, as far as daily gains were concerned, it was found that this factor was a relatively significant source of variation because the highest values of DG 1, DG 2 and DG 5 were found in singles, twins and triplets, resp. However, a highly significant ($P \leq 0.01$) difference between the levels of daily gains was recorded only in the case of DG 1.

Table 3. Phenotypic correlations between all growth characteristics under study

	BW 30	BW 70	BW 100	DG 1	DG 2	DG 3	DG 4	DG 5	DG 6
BW 0	0.383**	0.539**	0.509**	0.145	0.342**	0.410**	0.386**	0.114	0.401**
BW 30		0.540**	0.618**	0.969**	–0.128	0,518**	0.112	0.294**	0.604**
BW 70			0.798**	0.435**	0.766**	0.989 **	0.648**	–0.031	0.773**
BW 100				0.527**	0.468**	0.775**	0.851**	0.578**	0.993**
DG 1					–0.228**	0.445**	0.018	0.285**	0.540**
DG 2						0.770**	0.677**	–0.261**	0.450**
DG 3							0.634**	–0.053	0.768 **
DG 4								0.534**	0.851**
DG 5									0.599**

**$P \le 0.01$; *$P \le 0.05$

The afore-mentioned variability in DG 1, DG 2 and DG 5 was finally reflected in very uniform levels of daily gains in the period from birth to 100 days of age because for example the difference in their levels between singles and twins was only 7 g.

Age of dam had a significant effect on the majority of growth traits under study. Similar findings were reported by Křížek et al. (1992), Burfening and Carpio (1993) and Macit et al. (2001). It was also observed that BW 30, 70 and 100 of lambs increased with the increasing age of dams (from 2 to 4 years), however BW 30, BW 70 and BW 100 of lambs originating from five-years-old and older dams were approximately the same as in lambs of three-years-old dams. Lambs of two-years-old dams had highly significantly ($P \le 0.01$) lower (3.22 kg) birth weight compared with lambs of older dams (3.64 to 3.95 kg). As far as DG 6 was concerned, the highest and the lowest values (269 vs. 229 g) were recorded in lambs from four-years-old and two-years-old dams, respectively. Analla et al. (1998) and Matika et al. (2003) observed a similar trend while Dixit et al. (2001) reported that the highest daily gain from birth to 90 days of age was recorded in lambs originating from two-years-old dams.

The analysis of the effect of month of lambing on the growth of lambs indicated that this factor was a significant source of variation of daily gains. This is in agreement with the results by Carrillo and Segura (1993). Higher DG 1 and DG 5 were found out in lambs born in February whereas higher DG 2 and DG 6 were found out in lambs born in January. The most uniform levels of daily gains were recorded in the time interval from 70 to 100 days of age (J: 271 vs. F: 274 g) while the highest difference was observed in the time interval from 30 to 70 days of age (J: 248 vs. F: 167 g). Concerning body weights, this factor had a highly significant ($P \le 0.01$) effect only on BW 70 and BW 100 and higher BW 0, BW 70 and BW 100 were found out in lambs born in January. On the other hand, Ploumi et al. (1997) reported a highly significant effect of this factor also on birth weight of lambs.

Similarly like the month of lambing the year of lamb birth was a significant source of variation of daily gains. Higher DG 1, DG 5 and DG 6 were found out in lambs in the first year of evaluation while higher DG 2, DG 3 and DG 4 were found out in the second year. However, this factor had a significant effect on the majority of daily gains under study with the exception of DG 3 and DG 6. Most authors who studied the effect of this factor stated that it had a relatively marked effect on growth ability. The main reasons that can affect growth ability from the aspect of this factor are above all different nutrition and climatic conditions. In our study, however, lambs were reared only indoors and the above-mentioned conditions were practically identical in both years under study. This fact was reflected positively in a uniform level of DG 6 in both years under study although there were relatively great differences in levels of DG 1 and DG 2 depending on the concrete year of lamb birth.

The analysis of phenotypic correlations (Table 3) indicated that BW 0 showed a positive and highly significant ($P \le 0.01$) effect on the majority of growth traits under study. This is in agreement with the results of Dixit et al. (2001). All phenotypic correlations between body weights were positive and high ($P \leq 0.01$). The highest phenotypic correlations between body weights were observed between BW 30 and BW 100 and between BW 70 and BW 100. This analysis also revealed that the majority of phenotypic correlations between individual daily gains were positive and highly significant ($P \leq 0.01$). On the other hand, it was also found out that phenotypic correlations between DG 1 and DG 2 and between DG 2 and DG 5 were highly significantly ($P \leq 0.01$) negative in both cases. The highest phenotypic correlations between daily gains were observed between DG 2 and DG 3 and between DG 4 and DG 6.

CONCLUSIONS

The evaluation of the effect of genotype on growth showed above all that this factor did not have a significant effect on the majority of growth traits under study. On the other hand, the factor age of dam exerted a significant effect practically on all growth traits under study. Sex of lamb had a significant effect on all daily gains under study except the daily gain from birth to 70 days of age. Litter size, month of lambing and year of lamb birth were the most significant sources of variation of daily gains. As far as the phenotypic correlations between individual growth traits were concerned, it was found out that they were mostly positive and highly significant. On the other hand, it was also found out that phenotypic correlations between DG 1 and DG 2 and between DG 2 and DG 5 were highly significantly negative in both cases.

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