EFFECT OF CHAROLAIS DAMS' MATING METHOD AND PARITY ON GROWTH ABILITY OF THEIR PROGENY*

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The objective of this study was to determine the growth ability of Charolais bulls and heifers during the rearing period in relation to the sex of the animals, occurrence of twins, mating methods and parity of dams. A total of 584 animals born were observed in three herds of Charolais suckling cows from January 2000 to March 2007. The live weight at birth (BW) and at 120 (W120), 210 (W210) and 365 days (W365) of age in relation to herd-year-season, sex, occurrence of twins, mating method, and the dams' parity were evaluated. The statistical significances of the model used for evaluation were in all cases $P < 0.0001$, and the coefficient of determination ranged from $r^2 = 0.5012$ to $r^2 = 0.7867$. Differences in all live weights were significant ($P < 0.001$) in favour of bulls. Twins achieved lower live weight during the entire period, but it was significant only from birth to 210 days of age ($P < 0.0001$). It was confirmed that proven AI sires used in mating result in a higher growth ability of offspring, as offspring sired by AI bulls had lower BW, but higher W120, W210, and W365, with the difference being significant only at 365 days of age ($P < 0.05$). Calves of primiparous cows had significantly the highest BW ($P < 0.01$–0.001), but significantly the lowest W120 ($P < 0.0001$) and W210 ($P < 0.05$–0.001). These facts document the importance of sire selection for the mating of heifers and the lower milking ability of primiparous dams in relation to their own continuing growth.

beef cattle; sire; artificial insemination; natural service; live weight; sex; twins

INTRODUCTION

The period of improvement of beef breeds in the Czech Republic begun with the importing of 800 Hereford heifers in 1974, of Charolais heifers from Hungary, Germany and the Soviet Union by the end of 1990 and from France after 1991. A total of 5377 calves was born in the Czech Republic in 2006 (ČSCHMS, 2008a), which represents the number about 3700 more than the number of calves born in 1998 (Stádník et al., 1999). The objective of the breeder is to have all calvings completed within the shortest possible interval between the first and the last calving in the herd. A calving season lasting more than two months has an unfavourable effect on the body weight of calves at weaning. The length of the calving period is in relation to the length of the mating period (Louda et al., 2000). Breeders use artificial insemination (AI) or natural service (NS) to ensure cows' pregnancy. NS represented 78.1%, AI 20.4% and embryotransfer 1.5% of Charolais cow mating in 2006 (ČSCHMS, 2008a). Progeny testing of bulls and their subsequent using in AI offers higher genetic gain in future generations. Sire selection efficiency depends on the knowledge of accurate genetic parameters (Fouilloux et al., 1999).

The birth weight of calves is mostly affected by the breed (Szabó et al., 2006; Özlütürk et al., 2006), the sire (Fouilloux et al., 2000), the dam's age at the first mating and at calving (Roffeis, Muench, 2007), the sex of the calf (Steinwidder et al., 2007), or by the occurrence of twins (Krupa et al., 2005), etc. The required high growth intensity, presumably up to the age of four months, depends to a great extent on the milking capacity of dams. The body weight of calves at the age of 120 and 210 days represents the growth ability of calves during the suckling period. At the first stage, up to 120 days of age, body weight gain is particularly influenced by the milking capacity of the dam. In the second stage, from 120 to 210 days of age, the proper ability of the calf to utilize pasture is manifested. This period is limited by the time of weaning and is connected with the length of the calving season in relation to the month of herd transfer to pasture. Live weight at 365 days of age indicates the direct growth ability of the animal in relation to the quantity and quality of feeding during the second half of the pasture season and subsequent breeding or fattening in the stable. Moreover, the weaning or yearling live weight of animal is an important performance and breeding criterion for beef cattle (Szabó et al., 2007).

The objective of this study was to determine the growth ability of Charolais bulls and heifers during the rearing period in relation to the sex of the animals, occurrence of twins, service method and parity of dams.

MATERIAL AND METHODS

The experiment was performed in three herds of Charolais suckling cows. The number of cows bred in these herds during the years evaluated was from 20 to 50. A total of 584 animals born from January 2000 to March 2007

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were observed and measured during the evaluation. The number of bulls was $n = 298$ and of heifers $n = 286$ in the group of calves evaluated. The mating system in the herds involved seasonal mating or AI and subsequent seasonal calving in the period from December to June. All animals – cows, bulls, and observed calves as well were kept in pasture area during the entire grazing period (from May to October). The calves stayed together with the cows in the herd until the end of the pasture season. The monitored groups of bulls and heifers was subsequently housed in stables in groups of 20–30 animals and fed a feed ration based on basic components (silage with a higher % of dry matter, hay or straw) only during the winter period (from November to April). Heifers were bred for herd turn-over, and bulls were fattened after weaning.

The live weight (accuracy of 0.1 kg) of calves at birth (BW) and the live weight at 120 (W120), 210 (W210) and 365 days (W365) of age in relation to herd-year-season (HYS), the sex of the animal (SEX), occurrence of twins (TWINS), the mating method (REPRO), and the dam's parity at calving (PARITY) were all evaluated. The live weights were investigated in accordance with the Methodology of Performance Recording for Beef Cattle in the Czech Republic (ČSCHMS, 2008b). Data were collected from mating records, from performance records and from herd personnel records.

The coefficient of determination (r^2), the value of the F-test, the value of statistical significance (P) of factors included in the statistical model, and least square means, standard errors and levels of statistical significance ($P < 0.05$, $P < 0.01$, $P < 0.001$, $P < 0.0001$) as traits of differences among groups were used for statistical evaluation. The data set was analysed by ANOVA (Rasch, Mašata, 2006) through the statistical program SAS STAT 8.0 – GLM (SAS, 2001). The following equation was used:

$$Y_{ijklmn} = \mu + HYS_i + SEX_j + TW_k + REP_l + PAR_m + e_{ijklmn}$$

where: Y_{ijklmn} – observed value of the BW, W120, W210 and W365

μ – average value of dependent variable

HYS_i – fixed effect of i-herd-year-season of calving (3 herds, 8 years – 2000 to 2007, and 2 calving seasons – December to March, April to June, were considered)

SEX_j – fixed effect of j-class of sex (j = ♀, $n = 286$; ♂, $n = 298$)

TW_k – fixed effect of k-class of occurrence of twins (k = one, $n = 538$; twins, $n = 46$)

REP_l – fixed effect of l-class of the mating method (l = AI, $n = 118$; NS, $n = 466$)

PAR_m – fixed effect of m-class of dam's parity (m = 1st, $n = 83$; 2nd, $n = 100$; 3rd, $n = 81$; 4th, $n = 67$, 5th and subsequent, $n = 253$)

e_{ijklmn} – residual effects

The differences between estimated variables were tested at the levels of significance: $P < 0.05$ (*), $P < 0.01$ (**), $P < 0.001$ (***), $P < 0.0001$ (****).

RESULTS AND DISCUSSION

A data set of 584 bulls and heifers of the Charolais breed born from 2000 to 2007 in three suckler herds was monitored and evaluated during observation. Artificial insemination represented 20.21% of the reproduction methods of suckler cows, and natural service was used in remaining portion, 79.79%. This fact was in agreement with the situation in the entire population of Charolais cows in the Czech Republic (ČSCHMS, 2008a). However Golda et al. (1997) indicated that mating is realized mainly by AI because the keeping of bull is expensive. In relation to current results, breeders prefer natural service due to lower work requirements and better results of cows' conception. In all, 51.03% of bulls and 48.97% of heifers were born in selected herds during the evaluated period. A small difference was detected in comparison to general population results, but only by a 0.47% lower proportion of bulls and a higher share of heifers simultaneously (ČSCHMS, 2008a). However, a higher proportion of twins was observed, 7.88% in our data set but only 4.7% in the average entire population. The frequency of twins is related to the genetically fixed number of ovulated follicles, the ovulation rate and the number of fetuses (Echternkamp et al., 2007). It is possible to select for this genetic trait (Neumann et al., 1991). We divided the animals into 2 groups in relation to their birth date. The first group was represented by 77.91% animals born from December to March, which is the most suitable time for calving in suckler herds (Dufka, 1995; Golda et al., 1995). The second group consisted of 22.09% animals born from April to June. In all, 61.8% of the calves were born from December to March, 32.2% from April to June and 6% in other months in the Czech Republic during the last year of Performance recording (ČSCHMS, 2008b). The recommended length of the calving season is shorter than 2 months, because a calving season lasting more than two months has an unfavourable effect on the body weight of calves at weaning (Stádník et al., 1999).

Table 1 describes the basic statistical values of the evaluated linear model. The coefficient of determination ranged from $r^2 = 0.5012$ to $r^2 = 0.7867$ during evaluation of the observed traits, its lowest values being determined in relationship to the W120 and highest in relationship to the W365. Similar values of r^2 were determined in BW, W120, and W210 evaluation, and a significantly higher value of r^2 was detected in relation to W365 evaluation. The statistical significances of the model used for evaluation were in all cases $P < 0.0001$. The significance of the HYS effect was $P < 0.0001$ in all evaluations. The effect of HYS is a standard part of statistical evaluations of cattle performance (Vacek et al., 2007), and HYS is the most significant factor, which covers 64% of variability for BW, and 47% for W120 (Přibyl et al., 2000). We found that HYS explained from 72.27% to 81.55% of the variability in live weight from birth to 365 days of age. The significant effect of sex was found to be $P < 0.001$. The effect of sex is considered by many authors as very important (Teslík et al., 1995; Holton et al., 1995).

Table 1. Statistical significance of basic factors included in the linear model

		BW	W120	W210	W365
MODEL	r^2	0.5097	0.5012	0.5089	0.7867
	F-test	15.62	13.43	12.89	27.53
	P	< 0.0001	< 0.0001	<0.0001	< 0.0001
HYS	*F*-test	13.38	11.32	11.95	3.41
	P	< 0.0001	< 0.0001	<0.0001	< 0.0001
SEX	*F*-test	48.23	15.82	25.73	392.47
	P	< 0.0001	< 0.0001	<0.0001	< 0.0001
TWINS	*F*-test	36.80	64.69	44.24	2.58
	P	< 0.0001	< 0.0001	< 0.0001	0.1105
REPRO	*F*-test	0.35	1.82	2.49	4.72
	P	0.5549	0.1778	0.1156	0.0314
PARITY	*F*-test	4.07	14.82	5.55	3.32
	P	0.0029	< 0.0001	0.0002	0.0123

BW – birth weight of calves, W120 – live weight of calves at 120 days of age, W210 – live weight of calves at 210 days of age, W365 – live weight of calves at 365 days of age, HYS – effect of herd-year-season in model, SEX – effect of calves' sex in model, TWINS – effect of occurrence of twins in model, REPRO – effect of dam reproduction method, PARITY – effect of dams' parity, r^2 – coefficient of determination, *F*-test – value of *F*-test, *P* – value of statistical significance

Table 2. Effect of calves' sex, occurrence of twins and method of dam reproduction on live weight of calves at birth, 120, 210, and 365 days of age

		BW (kg)		W120 (kg)		W210 (kg)		W365 (kg)	
		μ + α	SE	μ + α	SE	μ + α	SE	μ + α	SE
SEX	♂ (*n* = 298)	38.21	0.427	163.79	3.22	270.40	4.64	507.64	12.662
	♀ (*n* = 286)	35.96	0.431	155.00	3.19	254.47	4.56	365.46	11.657
	P	****		****		****		****	
TWINS	no (*n* = 538)	38.97	0.27	178.86	1.93	285.23	2.87	453.90	5.25
	yes (*n* = 46)	35.21	0.66	139.93	5.11	239.63	7.25	419.20	21.83
	P	****	+	****	+	****	+		
REPRO	AI (*n* = 118)	36.93	0.56	161.86	4.10	266.34	5.70	445.06	12.90
	NS (*n* = 466)	37.24	0.36	156.93	2.83	258.53	4.14	428.05	11.61
	P							*	

AI – artificial insemination, NS – natural service, *P* = levels of statistical significance of differences among groups: $P < 0.05$ (*), $P < 0.01$ (**), $P < 0.001$ (***), and $P < 0.0001$ (****)

The significance of the effect of occurrence of twins varied from $P = 0.1105$ in W365 evaluation to $P < 0.0001$ in remaining evaluations. K r u p a et al. (2005) ascribed the significant effect of the occurrence of twins to the subsequent growth ability of calves during the rearing period. The effect of the reproduction method varied from $P = 0.5549$ in BW evaluation to $P < 0.05$ in W365 evaluation and was statistically significant only in W365 evaluation. The effect of parity ranged from $P < 0.05$ to $P < 0.0001$ and was statistically significant in evaluations of all traits. Our results confirmed the significance of the selected effects on the growth of beef cattle and were in agreement with findings of other authors (R o f f e i s , M u e n c h , 2007; S t e i n w i d d e r et al., 2007; S z a b ó et al., 2006).

Table 2 represents the effect of the animal's sex, the occurrence of twins and the mating method on observed live weights during the evaluated period. A statistical significance of the level $P < 0.001$ was detected in relation of sex to all live weights. The differences were 2.25 kg of BW, 8.79 kg of W120, 15.93 kg of W120, and 142.18 kg of W365 in favour of bulls. The average BW was 38.40 kg ($s_d = 5.22$), which correlates with finding of S t á d n í k et al. (1999), who determined the decline of BW from 42.92 kg in 1991 to 38.57 kg in 1997 as a positive result of prediction of breeding value for BW prediction, and viewed the more intensive selection of these traits as worsening the ease of calving of Charolais cows before the 1990's. Our results documented a different system of bull and heifer breeding after weaning. The differences were significant, but relatively slight from birth to 210 days of age, while the greatest difference was measured at 365 days of age in relation to the higher intensity of bulls' fattening after weaning. Similar results were described by S t e i n w i d d e r et al. (2007). Higher live weight of both sexes – heifers and bulls – in the Czech Charolais population can be found during the entire evaluated period, from

Table 3. Effect of dams' parity on live weight of calves at birth, 120, 210, and 365 days of age

		BW (kg)		W120 (kg)		W210 (kg)		W365 (kg)	
		μ + α	SE	μ + α	SE	μ + α	SE	μ + α	SE
PARITY	1st (*n* = 83)	38.74	0.59	145.66	4.34	248.85	6.04	424.84	15.31
	2nd (*n* = 100)	36.55	0.54	148.46	3.86	255.01	5.62	413.54	14.66
	3rd (*n* = 81)	36.54	0.60	165.31	4.30	269.32	6.00	447.66	14.86
	4th (*n* = 67)	36.99	0.59	170.16	4.16	269.50	5.91	448.20	13.43
	5th + (*n* = 253)	36.61	0.43	167.41	3.15	269.48	4.55	448.51	12.33
	P	1–2,5***; 2–3**		1–3, 4, 5****; 2–3, 4, 5****		1–3, 4; 1–5***; 2–3, 4*; 2–5**		1–5*; 2–3, 4*; 2–5**	

5th + – the 5th and subsequent parity of dam, *P* = levels of statistical significance of differences among groups: $P < 0.05$ (*), $P < 0.01$ (**), $P < 0.001$ (***), and $P < 0.0001$ (****)

birth to 365 days of age. Similar differences, 142.18 kg resp. 144.3 kg of live weight, were detected between bulls and heifers at 365 days of age only, while more significant differences were detected between bulls and heifers in the entire population simultaneously from birth to 210 days of age (ČSCHMS, 2008a). Differences of live weight in relation to the occurrence of twins were significant from birth to 210 days of age, and higher at 120 and 210 days of age than at 365 days of age, when the difference was lower and non-significant. We can summarize that the effect of twins reduces the growth ability of calves. However, in addition to this fact, Neumann et al. (1991) expressed the opinion that cows which have twins produce from 1.5 to 2 calves more during their life and that with regard to their genetic merit for twins they may be important for systematic dam breeding. A significant difference of W365 only was determined in relation to the reproduction method ($P < 0.05$), where offspring sired by AI bulls had a higher live weight at 365 days of age. The live weight at lower ages was non-significantly higher in this group of AI offspring as well, but the BW of animals born after AI was non-significantly lower by 0.31 kg. These results are in agreement with those of Stádník et al. (1999). It was confirmed that the usage of proven AI sires in breeding results in a higher growth ability of offspring due to genetic correlations for growth traits from 0.41 to 0.70 between Charolais AI sire and their progeny (Fouilloux et al., 2000). Our results, however, confirmed the significant contribution of the AI sire to W365 only. The same results were stated by Boleč ková (2008).

Table 3 describes the live weights of animals in relation to dams' parity. Calves of primiparous cows had significantly the highest BW ($P < 0.01$–0.001), from 1.75 kg to 2.2 kg. These results demonstrate the importance of sire selection oriented toward the birth weight of calves and the usage of these sires for mating of heifers. Otherwise, we can summarize that the risk of difficult calving of primiparous cows can greatly increase. The offspring of the youngest-primiparous cows reached the significantly lowest W120 ($P < 0.0001$) and W210 ($P < 0.05$–0.001), the differences being from 2.8 kg to 24.5 kg at 120 days of age and from 6.16 kg to 20.65 kg at 210 days of age. The results in table 3, lower W120 and W210, document the lower milking ability of primiparous dams and dams with second parity in relation to their own continuing growth. Calves of cows with third and subsequent parity achieved the highest W120, W210, and W365 ($P < 0.05$–0.0001). These findings are in agreement with the results of Stádník et al. (1999) and Roffeis, Muench (2007). Szabó et al. (2006) stated that the weaning weight of calves increased up to 5 years of the dam's age, which means up to the third parity.

CONCLUSION

A statistically significant effect of the HYS, sex, occurrence of twins, reproduction method, and dams' parity were determined. The differences in live weight between sexes in favour of bulls can help breeders in their decision about the use of sexed semen of AI sires, since bulls and offspring sired by AI bulls reach the highest live weight and growth ability. Twin calves achieved lower birth weight and all live weights during the observed period, but the question of higher beef production of twin-producing dams during their entire life can be discussed for possible implementation of this trait for selection schemes of beef cattle. On the other hand, this possibility contrasts with the common requirement of cattle breeders for one calf per parturition. The results indicate a need for better breeding conditions for primiparous and 2nd parity cows in order to ensure their own growth and better growth of their calves at the same time.

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Vliv metody plemenitby a pořadí otelení krav plemene charolais na růstovou schopnost jejich potomstva.

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Cílem práce bylo vyhodnotit růstovou schopnost býků a jalovic plemene charolais během odchovu v závislosti na pohlaví, výskytu dvojčat, způsobu plemenitby a paritě matky. Celkem bylo v letech 2000 až 2007 vyhodnoceno 584 zvířat ve třech stádech bez tržní produkce mléka. Byla hodnocena jejich živá hmotnost při narození a ve věku 120, 210 a 365 dnů ve vztahu k faktorům: stádo-rok-období, pohlaví, výskyt dvojčat, způsob plemenitby a parita matky. Statistická významnost modelu použitého pro vyhodnocení byla ve všech případech $P < 0{,}0001$ a koeficient determinace se pohyboval v rozpětí $r^2 = 0{,}5012$ až $r^2 = 0{,}7867$. Byly zjištěny statisticky významné rozdíly v živé hmotnosti ve prospěch býků ($P < 0{,}0001$). U dvojčat byla zjišťována nižší živá hmotnost v průběhu celého sledování, ale statisticky průkazné rozdíly byly potvrzeny pouze v období od narození do 210 dnů věku ($P < 0{,}0001$). Výsledky potvrzují, že používání prověřených býků v inseminaci přináší lepší růstovou schopnost potomstva, protože potomci pocházející z umělé inseminace měli nižší porod-

ní hmotnost a současně vyšší živou hmotnost ve 120, 210 i 365 dnech věku. Statisticky významný rozdíl byl potvrzen pouze ve věku 365 dnů ($P < 0,05$). Telata prvotelek měla při narození průkazně nejvyšší živou hmotnost ($P < 0,01–0,001$), ale také dosahovala průkazně nižší živé hmotnosti ve 120 dnech ($P < 0,0001$) a 210 dnech věku ($P < 0,05–0,001$). Tato skutečnost dokumentuje nižší mléčnost prvotelek v závislosti na jejich vlastním nedokončeném růstu.

masný skot; býk; umělá inseminace; přirozená plemenitba; živá hmotnost; pohlaví; dvojčata

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