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Usage of embryotransfer for increasing of calves growth ability in Charolais herd

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INTRODUCTION

The period of improvement of beef breeds in the Czech Republic began 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. Breeders use artificial insemination (AI) or natural mating (NM) to ensure cows´ pregnancy. NM represented 78.1%, AI 20.4% and embryotransfer (ET) 1.5% of Charolais cow mating in 2006 in the Czech Republic.

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 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 634 animals born from January 2000 to March 2007 were observed and measured during the evaluation. The number of bulls was n=323 and of heifers n=311 in the group of calves evaluated. The mating system in the herds involved seasonal mating, AI or embryotransfer 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 dataset was analysed by ANOVA through the statistical program SAS STAT 8.0 – GLM. 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 i- class of sex (j=♀, n=311; ♂ n=323),
TW_k = fixed effect of k- class of occurrence of twins (k=one, n=588; twins, n=46),
REP_l = fixed effect of l- class of the mating method (l=AI, n=118; NM, n=466; ET, n=50),
PAR_m = fixed effect of m- class of dam´s parity (m=1st, n=93; 2nd, n=110; 3rd, n=91; 4th, n=77, 5th and subsequent, n=263),
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

A dataset of 634 bulls and heifers of Charolais breed born from 2000 to 2007 in three suckler herds was monitored and evaluated during observation. Artificial insemination represented 18.61% of the reproduction methods of suckler cows, natural mating was used in 73.50% and embryotransfer represented portion of 7.88%. In all, 50.94% of bulls and 49.06% of heifers were born in selected herds during the evaluated period. However, a higher proportion of twins was observed, 7.26% in our dataset but only 4.7% in the average entire population.

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. 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.

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. 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 significance of the effect of occurrence of twins varied from P = 0.1105 in W365 evaluation to P < 0.0001 in remaining evaluations. The effect of the reproduction method varied from P = 0.5549 in BW evaluation to P < 0.05 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.

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 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. Higher live weight of both sexes - heifers and bulls - in the Czech Charolais population can be found during the entire evaluated period, from birth to 365 days of age. 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.

Higher live weight of calves from embryotransfer was detected at birth (+0.45 kg) and also at 120 days (+14.20 kg), but without statistical significance. The growth ability of calves born from embryotransfer was by 40 kg higher at 210 days of age ($P < 0.05$). A significant difference of W365 was determined in relation to the reproduction method ($P < 0.05$), where offspring sired by AI bulls and calves born from embryotransfer had a higher live weight at 365 days of age. A significant contribution of embryotransfer consists in 8% of mothers born after embryotransfer. Such cows increase the breeding value of the herd by production of their daughters for herd turnover and quality sons - bulls for artificial insemination. 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. 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. Our results, however, confirmed the significant contribution of the AI sire to W365 only.

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 other authors.

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 or embryotransfer 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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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	<.0001	<.0001	<.0001	<.0001
HYS	F-test	13.38	11.32	11.95	3.41
	P	<.0001	<.0001	<.0001	0.0001
SEX	F-test	48.23	15.82	25.73	392.47
	P	<.0001	<.0001	<.0001	<.0001
TWINS	F-test	36.80	64.69	44.24	2.58
	P	<.0001	<.0001	<.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	<.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=323)	38.21	0.427	163.79	3.22	270.40	4.64	507.64	12.662
	♀ (n=311)	35.96	0.431	155.00	3.19	254.47	4.56	365.46	11.657
	P	****		****		****		****	
TWINS	no (n=588)	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
	NM (n=466)	37.24	0.36	156.93	2.83	258.53	4.14	428.05	11.61
	ET (n=50)	37.69	0.40	171.13	3,55	295.53	13,26	481.31	39,15
	P					NM-ET*		AI-NM*, NM-ET*	

AI – artificial insemination, NM – natural mating, ET – embryotransfer, P = levels of statistical significances of differences among groups: P < 0.05 (*), P < 0.01 (**), P < 0.001 (***), and P < 0.0001 (****).

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 significances of differences among groups: P < 0.05 (*), P < 0.01 (**), P < 0.001 (***), and P < 0.0001 (****).