

ANALYSIS OF GROWTH DYNAMICS OF THE CZECH WARM-BLOOD BASED ON RESULTS OF GRADING OF COLTS IN REARING FACILITIES FOR TESTING YOUNG HORSES

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Abstract

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The objective of the study was to analyse the dynamics of growth of the Czech warm-blood young horses and to evaluate the effect of rearing facilities for testing young horses (RFT) on the increase in body measurements of the young horses. Groundwork data were obtained from the database of the Czech Warm-Blood Horse Breeders Association which contains data on the regular grading of the young horses in the RFT facilities. Data from the year 2001 to 2011 from 7 RFT facilities for young horses of the Czech warm-blood were entered in the basic database. Statistical processing of the database using the GLM method revealed that the RFT had a statistically significant effect on the tape-measure, heart-girth and bone. By multiple comparisons of the individual effects using the Tukey-B method we discovered statistically significant differences in body measurements of the young horses among the respective rearing facilities for testing young horses. The growth dynamics of young horses in the individual RFT considerably differed. The growth of young horses from the RFT Železnice was the most balanced showing no marked fluctuations. In the other rearing facilities the growth of the young horses fluctuated considerably in the course of the testing period; particularly in the Albertovec, Tlumačov and Luka-Týn rearing facilities for testing young horses the growth of the young horses was retarded in the second half of the testing period.

Czech warm-blood, young horses, rearing facilities for testing young horses, growth dynamics, body measurements, growth of young horses

The most common breed in the Czech Republic is the Czech warm-blood comprising 28% of the total number of horses bred in the Czech Republic (Misař, 2011). The present trend of using the Czech warm-blood horses in riding sports increases the demands for the quality of the horses. The Czech Warm-Blood Horse Breeders Association (CWA) carries out breeding to produce outstanding individuals to be qualified for show jumping or dressage. On the basis of selection progress in genetics has been achieved; the breed is developing and its average genetic level is increasing. The breeding value of an

individual and the time-dependent genetic level of the population represent the genetic progress of the population (Příbyl, 2008).

The breeding value (BV) is a relative figure which relates to the population in which it was estimated. The assessment of the BV is based on performance tests (Jiskrová, 2009). The mainstay of genetic progress in the performance of the Czech warm-blood is genetic information and phenotype manifestations of performance of the progeny of foals by sires used in the breeding of the Czech warm-blood (Zuravcová, 2009).

Act No. 154/2000 Coll. On selection, breeding and data recording of farm animals (Animal Breeding Act) as amended, based on Act No. 130/2006 Coll. is the legal basis for horse breeding in the Czech Republic. Selection is carried out on the basis of information and results of evaluations (Šarovská, 2010). Young horses and stallions are selected: at registration of foals, at selection of the rearing facility for testing young horses (RFT), during valuation in the RFT's, during basic performance tests, during the 100-day test, on granting selection for breeding and on the basis of information about the progeny.

Young horses of the Czech warm-blood are tested from weaning until they complete the basic performance tests of stallions in the RFT's. Operation in the RFT abides by the working regulations approved by the Czech Warm-Blood Horse Breeders Association (CWA). The RFT's serve several purposes. One of the most important is to provide complete data on the tested young horses and on the basis of the results of evaluations of the young horses to carry out performance tests of the parents. Another purpose is the selection of talented individuals predisposed to be used in riding sports (Nováková, 2010).

For selection to be correct it is important, among others, to be familiar with the heritability coefficient and qualities (conformation, jumping qualities) which determine the quality of the animal (Zuravcová, 2009). Dušek (1981) stated that for the stick-measure and tape-measure we can reckon with values of heritability h^2 in a range of 0.60 to 0.70; heart-girth ranges in values of $h^2 = 0.20$ to 0.30; the heritability coefficient of the bone ranges around 0.35.

Body measurements: stick-measure (stallions 162 to 170 cm, mares 161 to 167 cm) and bone (stallions 21 to 22.5 cm, mares 19.5 to 22 cm) are part of the breeding objective of the Czech warm-blood horse (Nováková, 2010).

The body conformation of the young horse changes with age. Initially the body conformation has the shape of an upright rectangle where the highest point of the withers extends the length of the body; gradually changes between the age of 12 and 18 months it gradually changes from rectangular to square. Later the body length slightly increases and the body conformation has the shape of a recumbent rectangle. In terms of the body conformation important is the stick-measure/spine proportion. After birth it changes very quickly as the horse becomes lower in the withers than in the hips and the horse is built downhill. At the age of 30 to 36 months this becomes balanced and the height at withers increases slightly; in adulthood by 1–3 cm higher (Dušek, 2007).

The objective of the study was to evaluate the growth dynamics of young horses in the individual rearing facilities for testing young horses (RFT); the statistical method was used to evaluate whether the RFT affected the growth of body measurements of the young horses.

MATERIAL AND METHODS

The groundwork database was created on the basis of results of tests of the young horses in the RFT in co-operation with the Central Records of Horses in Slatiňany. The database includes data from the following RFTs: Albertovec, Horní Město, Luka-Týn, Land Stud Farm Tlumačov, Měník, Stud Farm Suchá, Železnice. The young horses were appraised by a three-member committee consisting of a representative of the rearing section of the board of the Czech Warm-Blood Horse Breeders Association, consultant of the respective field and one member of the Studbook Council.

Groundwork data included results of regular spring and autumn grading of young horses in the RFTs in the period from 2001 to 2011. Only the results of horses which had completed the entire testing were evaluated and assessed. Incomplete data of young horses (due to death of the young horses during the testing or excluding the young horses from testing by decision of the assessing committee) were eliminated.

The database of each young horse consists of the name of the young horse, date of birth, identification number, life number, name of sire, name of dam, name of sire of dam, owner of the young horse, the rearing facility for testing young horses and body measurements (stick-measure, tape-measure heart-girth, bone) and grades for the body conformation, mechanics of movement and growth standard. The body conformation and mechanics of movement were graded on a scale of 1 to 5, the growth standard on a scale of -2 to +2. Body measurements are given in centimetres. The measurements of the young horses were carried out at the age of 6, 12, 18, 24, 30 and 36 months and are distinguished by indices 1 to 6.

Basic statistical processing was performed, the standard deviation was determined and the average characteristics of the growth standard and body measurements (stick-measure, tape-measure, heart-girth and bone).

Analysis of variance was performed using the GLM method and followed by tests for factors: rearing facility for testing young horses, year of grading the young horses in the RFT and the sire according to the model equation:

$$y_{ijkl} = \mu + p_i + s_j + y_k + e_{ijkl},$$

where:

μgeneral mean value

s_ieffect of the i^{th} rearing facility ($i = 1, \dots, 7$)

y_jeffect of the j^{th} year of test ($j = 1, \dots, 11$)

p_keffect of the k^{th} sire ($k = 1, \dots, 37$)

e_{ijkl}residue.

Where the results were statistically significant we conducted multiple comparisons of the individual effects using the Tukey-B method and the focus was on comparisons of the rearing facilities for testing the young horses. The effect of the sire and year

of the test were included in the model equation to eliminate their effect.

For processing the database and statistical evaluation we used the Excel and Unistat, version 5.1 programmes.

RESULTS

The groundwork database contained data from the year 2001 to 2011 from seven rearing facilities for testing young horses: RFT Albertovec, RFT Horní Město, RFT Luka-Týn, RFT Měník, RFT Suchá, RFT Tlumačov, RFT Železnice. Selected for the database were only young horses with complete data. The groundwork database contained data from individual classifications of 215 young horses by 37 different sires, in total 9,030 data. Basing on the groundwork database we evaluated sires which had 3 or more young horses with complete data in the groundwork database. Tab. I gives the numbers of young horses in the individual RFTs. The uneven distribution of the young horses in the rearing facilities for testing young horses is caused by missing data from some of the gradings of the young horses. The highest number of young horses with complete data came from the RFTs Horní Město, Suchá and Albertovec.

Graph 1 shows the evaluation of the growth standards of the young horses according to the rearing facility for testing young horses. Statistical

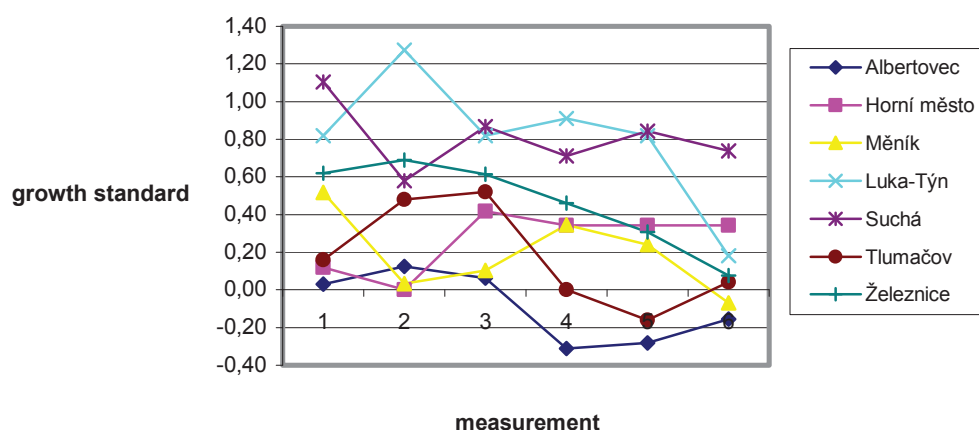
processing using the GLM method did not detect any significant differences among the rearing facilities for testing the young horses, but regardless the curves of the individual RFTs were different. The RFT Železnice showed a curve which had no marked fluctuations; at the time of arrival of the young horses at the RFT they were evaluation as slightly above the average of the growth standard and with increasing age the growth standard of the young horses easily achieved the average growth standard. Great fluctuations were monitored in the RFT Luka-Týn; after arrival of the young horses the growth in the first winter season considerably increased and during the following summer season growth rapidly decreased. Other measurements were balanced but during the last winter season of the testing period the growth standard greatly decreased. The growth curves of young horses in the RFT Suchá and Měník were similar; in the first winter season after arrival of the young horses in the RFT the growth standard decreased considerably and the growth standard curve then evened out.

Young horses from the RFT Suchá showed considerably higher values of the growth standard at the end of the testing period; young horses from the RFT Albertovec and Měník showed lower values of the growth standard at the end of the testing period. Graph 2 shows the increase in the stick-measure of the young horses divided according to the respective rearing facilities. The increase in the stick-measure of the young horses did not differ much among the rearing facilities; only the stick-measure of young horses in the rearing facility Suchá was higher in the second part of the testing period. In contrast young horses from the RFT Albertovec had the lowest stick-measure during the entire second part of the testing period. Even so they achieved higher average values than other authors reported. Dušek (2007) reported that the average stick-measures in young horses of the Czech warm-blood were somewhat lower – at 6 months of age 127.8 cm, at 12 months 146.2 cm, at 24 months 156.7 cm and at 36 months 161.4 cm.

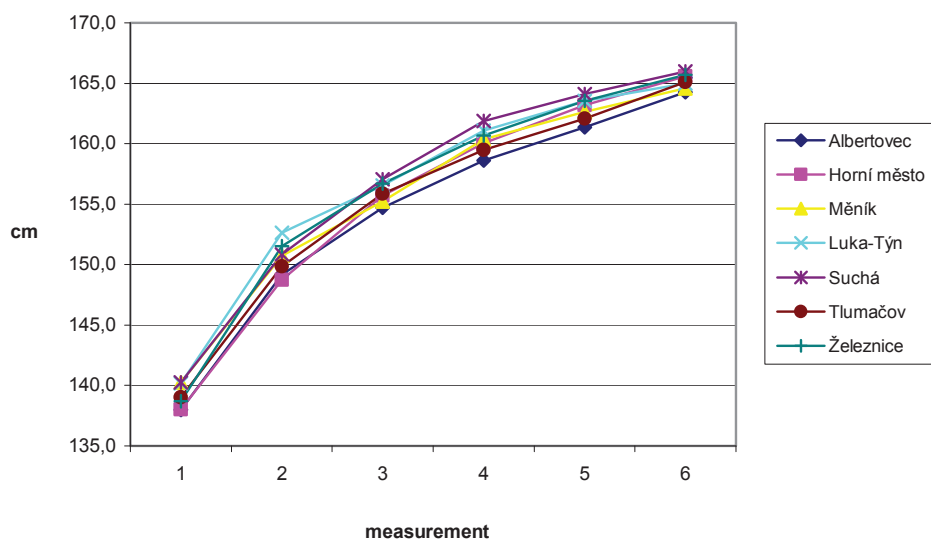
Graph 3 demonstrates the growth in tape-measure in young horses divided according to the individual

I: Number of young horses included in the database in rearing facilities for testing young horses

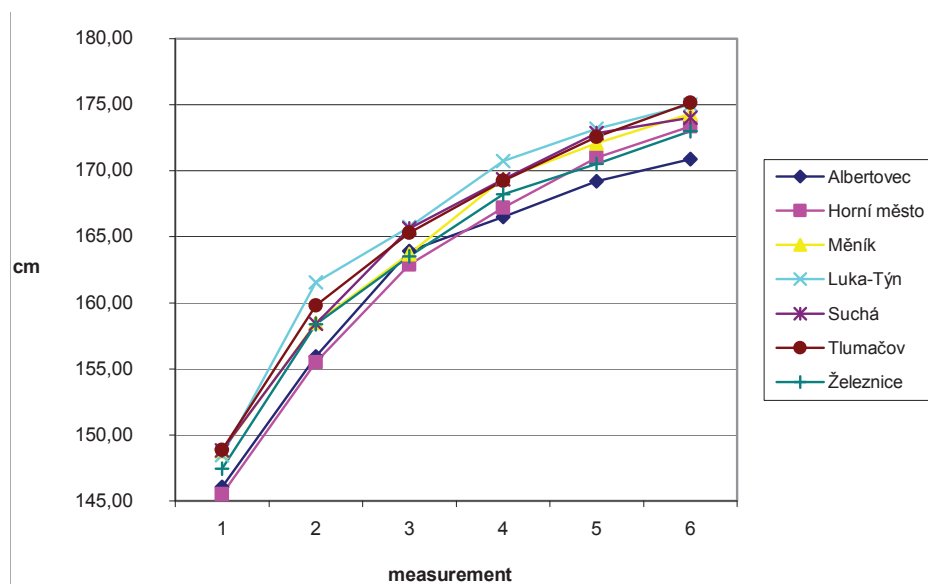
Rearing facilities for testing young horses	Number of young horses
Albertovec	32
Horní město	67
Měník	29
Luka-Týn	11
Tlumačov	25
Železnice	13
Suchá	38



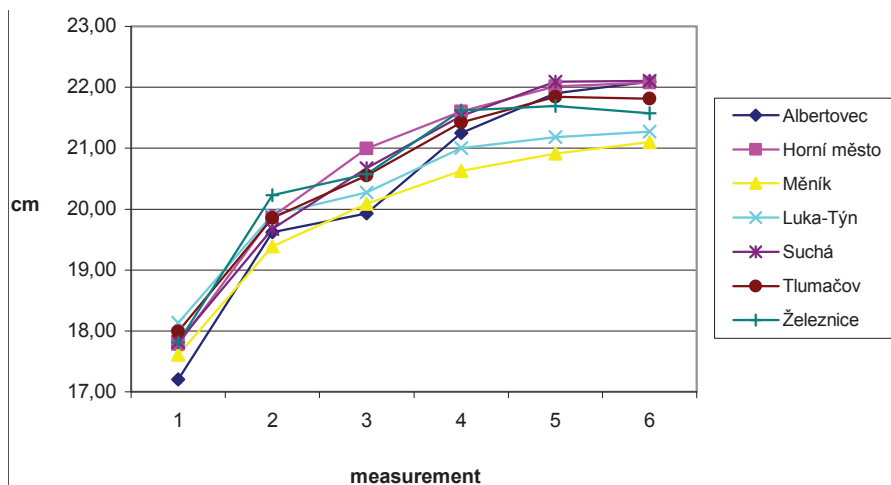
1: Growth standards of the young horses



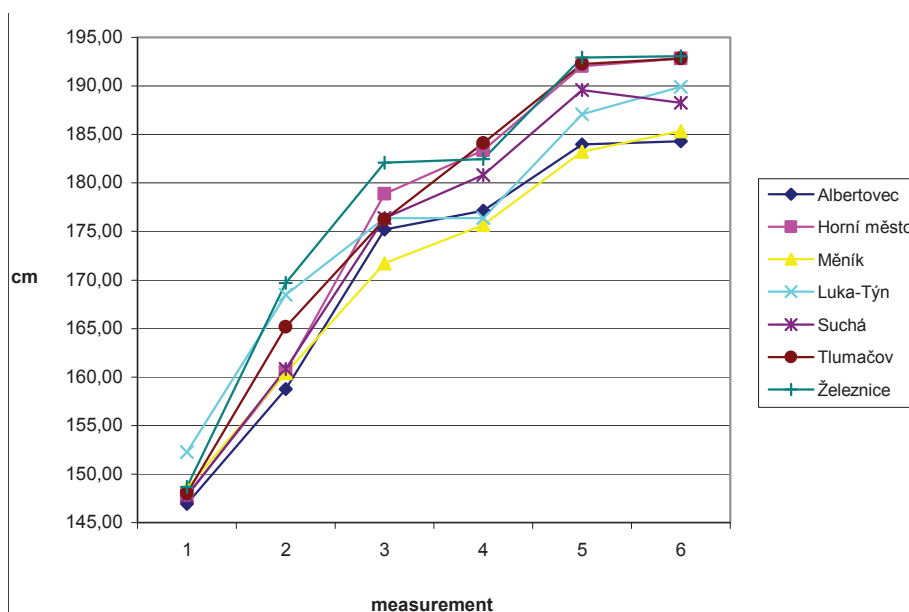
2: Average stick-measures of young horses in the RFT



3: Average tape-measures of young horses in the RFT



4: Average value of bone of young horses in the RFT



5: Average heart-girth of young horses in the RFT

rearing facilities. It shows the fluctuations in the growth of the tape-measure in the rearing facility Luka-Týn; particularly the rapid growth of the tape-measure during the first winter after arrival of the young horses to the RFT. This corresponds with Graph 1 showing that young horses in the RFT Luka-Týn achieved higher growth standards in the period after the first winter, and with Graph 2 showing that young horses achieved higher stick-measures after the first winter period. In the Albertovec rearing facility the increase in the tape-measure of young horses aged 24–36 months was lower than in young horses in the other rearing facilities. Dušek (2007) again reported that the average tape-measures of Czech warm-blood young horses were lower – at the age of 6 months 134.4 cm, at 12 months 154.8 cm, at 24 months 165.6 cm and at 36 months 170.3 cm.

Graph 4 illustrates the growth of the bone measure divided according to the individual rearing facilities for testing young horses. The curves of the growth of the bone of young horses in the RFT Železnice and Albertovec fluctuated; in both of these RFTs the growth of the bone markedly decreased after the first summer season. The slower growth of the bone was not accompanied by a considerably slower growth in the height of the young horses. The rearing facilities for testing young horses Měník and Horní Město showed curves with no marked fluctuations in the bone growth. Dušek (2007) reported the same average measurements of the bone of Czech warm-blood young horses – at 6 months 16.3 cm, at 12 months 19.7 cm, at 24 months 21.1 cm and at 36 months 21.6 cm. At 36 months of age the bone of young horses from the Měník and Luka-Týn RFTs was smaller than reported by Dušek (2007). Young horses from these RFTs also had a lower stick-measure, but higher tape-measure

than young horses from the other rearing facilities for testing young horses.

Graph 5 illustrates the growth of the heart-girth divided according to the individual rearing facilities for testing young horses. Marked fluctuations in the growth of the heart-girth were seen in young horses from the RFT Železnice, Luka-Týn and Suchá after the second winter period. The curve from the RFT Měník showed no marked fluctuations in the growth of the heart-girth. Dušek (2007) reported the same average measurements of the heart-girth of Czech warm-blood young horses – at 6 months 130.0 cm, at 12 months 162.8 cm, at 24 months 180.2 cm and at 36 months 189.2 cm. At 36 months of age the heart-girth of young horses from the RFT Měník and Albertovec was smaller than reported by Dušek (2007).

Tab. II gives the results of analysis using the GLM method to determine the statistically significant effect of the RFT on the body measurements of the young horses. The rearing facility for testing young horses had a highly statistically significant effect ($p < 0.001$; in the table marked **) on the tape-measure (first and second measurements), on the bone (4th, 5th and 6th measurements) and on the heart-girth (2nd, 5th and 6th measurements). The rearing facility also had a statistically significant effect ($p < 0.05$; in the table marked *) on the tape-measure (3rd measurement), bone (2nd measurement) and on the heart-girth (4th measurement). It was interesting to discover that the RFT had a statistically highly significant effect on the tape-measure at the first measuring which is done on arrival of the young horses at the RFT. In point of fact, when the young horses arrive at the RFT, the RFT cannot have had an impact on the growth of body measurements of the young horses. This is the case when the majority of the young horses starting in the testing come

II: *Effect of the RFT on body measurements in the respective periods*

Body measurements	Average	Standard deviation	Level of significance	Body measurements	Average	Standard deviation	Level of significance
stick-measure 1	138.99	4.31		bone 1	17.72	1.40	
stick-measure 2	149.94	4.31		bone 2	19.76	0.94	
stick-measure 3	155.85	3.76		bone 3	20.54	1.56	*
stick-measure 4	160.23	3.82		bone 4	21.36	0.88	
stick-measure 5	162.91	3.64		bone 5	21.78	0.92	**
stick-measure 6	165.25	3.78		bone 6	21.85	0.86	**
tape-measure 1	147.27	4.87	**	heart-girth 1	148.07	8.05	
tape-measure 2	157.47	4.90	**	heart-girth 2	161.81	7.48	**
tape-measure 3	164.11	4.25	*	heart-girth 3	176.68	7.09	
tape-measure 4	168.25	4.27		heart-girth 4	180.61	9.19	*
tape-measure 5	171.48	3.96		heart-girth 5	189.04	7.89	**
tape-measure 6	173.51	4.11		heart-girth 6	189.61	6.76	**

III: *Statistically significantly different pairs – tape-measure*

RFT	Tape-measure ₁							Tape-measure ₂							Tape-measure ₃						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1 Albertovec										*			*								
2 Horní Město			*		*	*				*	*	*	*							*	
3 Měník		*							*												
4 Luka-Týn								*	*												
5 Suchá		*							*							*					
6 Tlumačov		*						*	*												
7 Železnice																					

IV: *Statistically significantly different pairs – bone*

RFT	Bone ₃							Bone ₅							Bone ₆						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1 Albertovec			*							*							*				
2 Horní Město			*							*							*	*			
3 Měník	*	*			*	*	*	*	*			*	*		*	*			*	*	
4 Luka-Týn																*			*		
5 Suchá			*							*							*	*			
6 Tlumačov			*							*							*				
7 Železnice			*																		

from a rearing facility for testing young horses and therefore their nutritional condition is similar.

On the basis of multiple comparisons of the individual effects using the Tukey-B method statistically significant differences were discovered in the body measurements of young horses from the individual rearing facilities for testing young horses. Tab. III shows that the tape-measure of young horses in RFT Horní město and Albertovec was significantly lower. The tape-measure of young horses in the Tlumačov, Suchá, Luka-Týn and Měník RFTs was demonstrably higher. Differences in the average tape-measure ranged between 3 and 15 cm.

As can be seen in Tab. IV the young horses in the Měník and Luka-Týn rearing facilities for testing

young horses had a demonstrably smaller bone than young horses in the Tlumačov, Suchá, Albertovec, Horní město and Železnice facilities. From the results it is demonstrable that young horses from the Horní město and Albertovec rearing facilities for testing young horses had a smaller tape-measure but at the same time a larger bone than young horses from the RFT Měník.

Tab. V shows statistically significant pairs; the variable is the heart-girth and the effect the rearing facility. The table demonstrates that young horses from the Tlumačov, Železnice, Luka-Týn and Horní Město rearing facilities for testing young horses have a larger heart-girth than young horses from Albertovec, Měník and Suchá.

V: Statistically significantly different pairs – heart-girth

RFT	Heart-girth ₂							Heart-girth ₄						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1 Albertovec				*		*	*		*				*	
2 Horní Město				*		*	*	*		*				
3 Měník				*			*		*				*	
4 Luka-Týn	*	*	*		*									
5 Suchá				*			*							
6 Tlumačov	*	*						*		*				
7 Železnice	*	*	*		*									

RFT	Heart-girth ₅							Heart-girth ₆						
	1	2	3	4	5	6	7	1	2	3	4	5	6	7
1 Albertovec		*			*	*	*		*			*	*	*
2 Horní Město	*		*					*		*		*		
3 Měník		*			*	*			*				*	*
4 Luka-Týn														
5 Suchá	*		*					*	*				*	
6 Tlumačov	*		*					*		*		*		
7 Železnice	*		*					*		*				

It is evident from the results that young horses from the RFT Albertovec have a smaller heart-girth, smaller tape-measure but larger bone. It was proved that young horses from the RFT Tlumačov have a larger heart-girth, larger bone and higher tape-measure. It was also proved that young horses from the RFT Luka-Týn have a larger heart-girth, smaller bone and higher tape-measure, and that young horses from the RFT Železnice have a larger heart-girth. Young horses from the Horní Město rearing facility for testing young horses have a demonstrably larger heart-girth, larger bone and smaller tape-measure. It was demonstrated that young horses from the RFT Suchá have a smaller heart-girth than young horses from the Luka-Týn, Železnice, Tlumačov and Horní Město RFTs, but a larger heart-girth than young horses from the Měník and Albertovec rearing facilities for testing young horses. At the same time these young horses have a larger bone and higher tape-measure. It was demonstrated that young horses from the RFT Měník have a smaller heart-girth, smaller bone and higher tape-measure.

The curve of the growth standard reflects the quality of the feed taking into account the changing demands of the young horses during their growth. The keystone of correct horse nutrition during growth is high-quality pasture with an optimal species composition (Dušek, 2007). Among others, the subsoil and the soil on which the pastures grow influence the quality and species composition of the pastureland. Undesirable is both a lack and over-supply of good-quality feed which is reflected in the growth curve by a marked decrease or increase in the height of the young horses. The growth dynamics of the young horses can be expected to decrease during the winter season considering the

absence of grazing. The results of the study did not confirm that growth of the young horses in winter was slower than in summer when they could graze on good-quality pastureland. As an example we can take young horses from the Luka-Týn rearing facility for testing young horses which markedly increased growth in the first winter season and in the following summer season their growth markedly decreased. Along with higher growth dynamics during the winter these young horses also became sturdier but not more angular. This fact can be explained by the nutritionally exceedingly rich feed in the winter and on the other hand insufficient supplementary feeding in the summer grazing season. As another example we can take young horses from the Měník and Suchá RFTs where the growth of the young horses decreased markedly in the first winter season. In spite of this these young horses were sturdier after the first winter season indicating that they received feed with a balanced nutrient ratio and lower nutritional value. The average height of young horses from the Suchá rearing facility for testing young horses considerably increased after the grazing season and the young horses were bonier. The curve of the bone growth of young horses from the RFTs Železnice, Luka-Týn and Albertovec markedly decreased after the second winter season, the result of the not so well balanced nutrient ratio in the feed ration in the winter which did not reflect the higher demands of the growing young horses for nutrient uptake.

CONCLUSION

The database contained data from the year 2001 to 2011 from seven rearing facilities for testing young horses: RFT Albertovec, RFT Železnice,

RFT Tlumačov, RFT Měník, RFT Horní město, RFT Luka-Týn, RFT Suchá. An analysis using the GLM method showed that the RFT had a statistically significant effect on the body measurements of the young horses – on the tape-measure, heart girth and bone. The effect of the RFT on the stick-measure was insignificant. Multiple comparisons of the individual effects using the Tukey-B method showed statistically significant differences in the body measurements of the young horses among the individual rearing facilities for testing young horses.

The highest young horses came from the Suchá, Horní Město and Luka-Týn rearing facilities for testing young horses, and at the end of the testing period they were evaluated as above the average of the growth standard. The smallest young horses came from the Měník and Albertovec rearing facilities for testing young horses and at the end of the testing period were evaluated as below the average of the growth standard. The significantly sturdiest young horses came from the Suchá, Tlumačov and Luka-Týn rearing facilities for testing young horses; the significantly least robust were young horses from the Albertovec rearing facility for testing young horses. Young horses with the boniest frame proved to be from the Suchá, Albertovec and Horní město rearing facilities for testing young horses; at the end of the testing period their average bone was 22.1 cm. The least bony young horses were from the RFTs Luka-Týn and Měník; their average

bone at the end of the testing period was 21.27 cm and 21.07 cm, respectively. At the end of the testing period great differences were found in the heart-girth among the young horses. Young horses with the largest heart-girth were from the Železnice, Tlumačov and Horní Město RFTs; their average heart-girth was 193 cm. Young horses from the Měník and Albertovec RFTs the smallest heart-girth; the average was 185 cm and 184 cm, respectively.

In conclusion we can say that young horses from the RFT Měník were smaller and had a smaller heart-girth and bone. Young horses from the RFT Albertovec were smaller, demonstrably less robust, but bonier. Young horses from the RFT Luka-Týn were bigger, demonstrably sturdier, but not so bony.

The growth dynamics of young horses in the individual rearing facilities for testing young horses differed a great deal. Results of the present study did not prove the general assumption that in the winter the growth of the young horses is slower than in summer when good-quality pasture is available. The growth of young horses from the RFT Železnice was the most balanced with no marked fluctuations. In the other rearing facilities for testing young horses the growth dynamics of the young horses during testing fluctuated; particularly in RFTs Albertovec, Tlumačov and Luka-Týn the growth dynamics declined considerably in the second half of the testing period.

SUMMARY

The objective of the study was to analyse the dynamics of growth of young horses of the Czech warm-blood and to evaluate the effect of rearing facilities for testing young horses (RFT) on the increase in body measurements of young horses. Groundwork data were obtained from the database of the Czech Warm-Blood Horse Breeders Association which contains data on the regular grading of the young horses in the RFT. The database contains data from the year 2001 to 2011 from seven rearing facilities for testing young horses. Only young horses with complete data of measurements were entered in the database – of stick-measures (SM), tape-measures (TM), heart-girth (G) and bone (B) with evaluations of the growth standard, evaluation of the conformation and evaluation of the mechanics of movement. The young horses were measured for the above at 6, 12, 18, 24, 30 and 36 months of age.

A database counting 9,030 data was created in order to evaluate statistical results based on regular grading of 215 young horses by 37 different stallions. The GLM method was used for the statistical evaluation taking into account the effect of the following factors: the rearing facility for testing young horses, sire and year of grading of the young horses in the RFT. The RFT had a statistically significant effect on the following: tape-measure, heart-girth and bone. By means of multiple comparisons of the individual effects using the Tukey-B method statistically significant differences were discovered among the individual RFT' in the growth of young horses.

The growth dynamics of the young horses differed in the respective rearing facilities for testing young horses. The growth of young horses in the RFT Železnice was the most balanced and showed no marked fluctuations. In the other rearing facilities for testing young horses the fluctuations in the growth of young horses were more marked during the testing period; particularly in the second half of the tests the growth of young horses from the RFT Albertovec, Tlumačov and Luka-Týn slowed down. The significantly most robust young horses were seen in the RFT Suchá, Tlumačov and Luka-Týn; the significantly least robust young horses were from the RFT Albertovec. The significantly boniest young horses came from the RFT Suchá, Albertovec and Horní město; their average bone at the end of the testing period was 22.1 cm. The least bony young horses came from RFT Týn and Měník and their average bone at the end of the testing period was 21.27 cm and 21.07 cm, respectively. Young horses with the significantly largest heart-girth came from the RFT Železnice, Tlumačov and Horní Město; their average heart-girth was 193 cm. Young horses from the RFT Měník and Albertovec have the significantly smallest heart girth; on average 185 cm and 184 cm, respectively.

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