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Environmental Factors Affecting Growth Characteristics in Purebred Arabian Foals Reared at Anadolu State Farm in Turkey

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Abstract: The purpose of this study was to determine the level of growth characteristics and to investigate the effects of environmental factors on these characteristics in purebred Arabian foals reared at Anadolu state farm at Eskisehir province in Turkey. The study was carried out on the date obtained from 1681 foals at birth, 268 foals at 6 month, 422 foals at one years of age, 160 foals at 2 years of age and 37 foals at 3 years of age between the years 1987 and 2007. Although, the effect of foaling month was insignificant ($p>0.05$), the effects of foaling age, foaling year and sex of foals on birth weight were significant ($p<0.001$-$p<0.05$). Colts weighed 46.27±0.40 kg at birth, while fillies weighted 45.22±0.40 kg at birth. Means of body weights at birth was 45.74±0.31 kg. The average values for withers height of colts and fillies at birth, 6 month (at weaning), 1, 2 and 3 years of age were 96.66±0.08, 136.29±0.34, 142.18±0.42, 149.80±0.37 and 151.79±0.78 cm, respectively. Average values heart girth were 80.06±0.08, 148.16±0.48, 156.70±0.36, 170.96±0.54 and 175.33±0.99 cm, respectively. The average values for body length foals at birth, 6th month, 1, 2 and 3 years of age were, respectively 69.03±0.23, 122.01±0.39, 132.08±0.86, 142.04±0.46, 145.08±1.00. Averages values for cannon bone circumference were10.63±0.10, 16.64±0.07, 17.73±0.04, 18.82±0.08, 19.32±0.11, respectively. At the end this study, it was concluded that growth performance of purebred Arabian horses reared at Anadolu state farm were good. Mean values of body measurement at some periods (birth, 6 month, 1, 2 and 3 year) can be used to control growth of foals in this farm and growth performance of foals was evaluated according to these values.

Key words: Horse, purebred Arabian, environmental factors, growth traits, performance, body measurement

INTRODUCTION

Body measurements of horses could be useful to show their characteristics and general body conformation. These measurements might be used to compare between normal and abnormal growth rates. Body conformation is useful in evaluating and comparing breeds. Beauty of horses and their performance in sports are affected by their body conformation. Part of the beauty of the Arabian horse depends on its body conformation, body measurements and the relationships among the dimensions (Sadek *et al*., 2006). In addition to, wither height of mature horses is positively correlated with racing performance and stride length (Smith *et al*., 2006).

Growth of foals was determined by a lot of allele gene. Growth can be classified as prenatal growth (growth in uterine) and postnatal growth (growth after birth), which can be observed well and measured quantitatively. Growth in uterine or prenatal growth was evaluated with birth weight. However, postnatal growth or growth after birth was evaluated with body measurements in successive intervals.

Growth of foals can be affected by many factors, some genetic (breed of mare, breed of stallions, etc.) others environmental. Environmental factors can be classified as factors with measurable effects (age of mares, parity, foaling year, breeding month, etc.) and factors with un-measurable effects (infectious diseases, parasitic enfestations, etc.). The measurable effects can be determined and these factors can be used in the management of the farm (Yalçin, 1975; Cilek, 2008a, b).

Growth of foals can be evaluated and can be controlled with changes of measurements of wither height, cannon bone circumference, heart girth and body length. Therefore, factors affecting body measurements and growth of foals should be known well. Low values of measurement of body in certain time can be reason of insufficient feeding and chronic diseases and can be used management in the farm.

Demirtel (1975) reported, the average values of wither height, heart girth and cannon bone circumference in purebreds were 135.3-170.2 and 19.2 cm for females and 137.6-172.0 and 20.5 cm for males, respectively at the age of 3 at Karacabey state farm in Balikesir province in Turkey.

In Anadolu state farm, Average values for withers height of colts and filies at birth and 6th month were, respectively 96.40 and 95.38 cm, 128.89 and 128.26 cm, average values heart girth were 79.38 and 79.29 cm, 133.40 and 133.13 cm in the same order (Koç, 1990). Colt weighed 45.36 kg at birth and 197.17 kg at 6th month while filies weighted 44.60 kg at birth and 192.45 kg at 6th month. The average values for body length of colts and fillies at birth and 6th month were 68.15 and 68.07 cm, 119.55 and 117.86 cm, respectively and averages values for cannon bone circumference were 10.78 and 10.68 cm, 15.73 and 15.51 cm, respectively. Average values of the same traits were, respectively 152.24 and 18.67 cm for mares and 152.94 and 19.16 cm for stallions (Koç and Altinel, 1992).

Arabian colts weighted 46.35 kg at birth, 276.74 kg at 12th month and 372.27 kg at 24th month while filies weighted 45.65 kg at birth, 264.67 kg at 12th month, 356.67 kg at 24th month and 402.0 kg at 36 th month the effect of sex on the 6th month cannon bone circumference was significant (Altinel and Küçük, 1992).

Height at withers, circumference of front shank, chest girth, chest width, body length and height at rump of mares ageing 12-60 months were found as 151.0±0.55, 19.2±0.08, 165±0.62, 37.2±0.16, 139.2±0.81 and 142.3±0.23 cm, respectively. The differences among age groups were determined as statisticaly significant (Özdemir, 1998).

The average values of height at withers, heart girth and cannon bone circumference for 224 colts and 319 fillies younger than 24 months were calculated to be 141.634±0.212, 152.99±0.33 cm and 17.87±0.04 and 140.826±0.18, 153.94±0.33 and 17.47±0.04 cm, respectively. In addition, the average values of these body measurements were calculated for 311 colts and 73 fillies 25-36 months old as follows: 152.099±0.16, 173.61±0.25 cm and 19.58±0.03 cm and 149.288±0.32, 171.26±0.69 and 18.28±0.07 cm, respectively (Dogan *et al*., 2002).

In native horses in Van region of Turkey, the least squares means of height at withers, body length, height at rump, chest depth, chest width, heart girth circumference and cannon circumference were 137, 130, 136, 56, 46, 165 and 17.4 cm, respectively. The effect of age on body length and chest width was significant ($p<0.05$ and $p<0.01$) (Bayram *et al*., 2005).

Effects of ages of dam, sex and year of birth on the weights of foals at birth and 6 month were investigated. The effect of age of dam on birth weight was significant. The effects of ages of dam of variation on 6th month weights of foals were not significant. Effect of year of birth on birth weight and 6th month weight were not significant. The effect of sex was significant only for weight at 6th month of age (Koç and Altinel, 1992).

This study was conducted to investigate the environmental factors affecting growth traits of purebred Arabian horse raised between 1987 and 2007 at the Anadolu state farm.

MATERIALS AND METHODS

This study was carried out to determine birth weight, height at withers, heart girth and cannon bone circumference and body length measurements in purebred Arabian colts and fillies at Anadolu State Farm. Data obtained from the 1987-2007 breeding data and marketing catalogue for birth, 6 months of age, 1, 2 and 3 years of age were used. Four body measurements (withers height, cannon bone circumference, heart girth, body length (cm)) and birth weight (kg) were taken. All measurements were taken while the horse was standing on a flat ground in right position with parallel legs. Circumference measures were taken by a tape while withers height was taken by a specially designed caliper. The effects of age of dam, sex and genotypes on the growth characteristics (body measurements and birth weight) were investigated. The effects of age of dam, sex of foal, foaling year and foaling month on the growth characteristics were investigated.

Fourteen age groups were formed beginning from 5 years and ending at 18 years and older for foaling age; 5 groups for foaling month (from January to May), 2 groups for sex of foals and 21 groups for calving year, between 1987 and 2007. Environmental factors which influenced birth weight, height at withers, heart girth and cannon bone circumference and body length were investigated. The General Linear Model (GLM) was used for variance analyses of gowth traits. Duncan's multiple range test was used for multiple comparisons between groups.

RESULTS AND DISCUSSION

The least square means of withers height, cannon bone circumference, heart girth and body length of foals at birth was presented Table 1. Effects of sex of foals, foaling age, foaling month and foaling year on withers height at birth were statistically very significant ($p<0.001$). Withers height at birth was the shortest at 94.84±0.22 cm in 5 years of age, the highest at 97.64±0.37 cm in 17 years of age. Withers height at birth was the shortest at 95.84±0.18 at January, the highest at 97.27±0.13 at February.

Effect of foaling year on cannon bone circumference at birth was very significant ($p<0.001$). Effects of other factors were statistically insignificant ($p>0.05$).

Table 1: The least square means of withers height, cannon bone circumference, heart girth and body length of foals at birth

Factors	n	Withers height	Cannon bone circumference	Birth weight	Heart girth	n	Body length
Age		***	ns	***	***		***
5	171	94.84±0.22d	10.29±0.26	42.72±0.83b	77.93±0.21d	28	67.28±0.55e
6	171	95.08±0.22d	10.94±0.26	43.56±0.83b	78.68±0.21d	16	66.20±0.69f
7	155	96.10±0.23c	10.52±0.27	44.37±0.86b	79.59±0.22bc	17	67.82±0.67de
8	166	96.25±0.22bc	10.49±0.27	44.74±0.84b	79.71±0.21b	14	67.27±0.73e
9	148	97.02±0.23abc	10.50±0.28	45.96±0.88b	80.05±0.22b	18	67.91±0.65de
10	133	96.83±0.24abc	11.21±0.29	45.83±0.92b	80.40±0.23ab	15	70.31±0.75ab
11	111	97.25±0.26ab	10.58±0.32	46.30±1.01b	80.52±0.25ab	16	68.67±0.69cd
12	108	96.98±0.27abc	10.55±0.33	49.83±1.03a	80.71±0.26ab	9	69.61±0.93bc
13	97	97.33±0.28ab	10.62±0.34	46.35±1.08b	80.67±0.27ab	11	70.83±0.83a
14	89	97.20±0.30abc	10.64±0.36	45.90±1.13b	80.46±0.28ab	8	69.91±0.98ab
15	73	97.11±0.32abc	10.60±0.39	46.41±1.24b	80.60±0.31ab	5	70.63±1.23ab
16	60	96.93±0.36abc	10.59±0.43	46.03±1.37b	80.52±0.35ab	13	69.66±0.78a
17	57	97.64±0.37a	10.59±0.45	46.68±1.41b	81.31±0.36a	12	70.64±0.84ab
18>	142	96.70±0.23abc	10.73±0.28	45.73±0.89b	79.62±0.23bc	21	69.70±0.63bc
Month		***	ns	Ns	ns		*
1 (January)	257	95.84±0.18c	10.49±0.21	44.66±0.67	80.39±0.17	29	67.32±0.57c
2(February)	470	97.27±0.13a	10.97±0.16	46.89±0.50	80.05±0.13	65	69.37±0.35b
3 (March)	484	97.01±0.13ab	10.51±0.16	45.90±0.50	80.03±0.13	64	68.82±0.38b
4 (April)	347	96.74±0.15ab	10.63±0.18	45.64±±0.58	79.99±0.15	25	69.13±0.59b
5 (May)	123	96.44±0.25b	10.55±0.30	45.62±0.95	79.81±0.24	20	70.52±0.63a
Year		***	***	*	***		***
1987	60	95.35±0.36f	10.74±0.43ab	45.68±1.36ab	80.02±0.34cdef	60	68.01±0.39b
1988	50	95.84±0.39ef	10.75±0.47ab	45.20±1.49ab	80.11±0.38cdef	49	68.66±0.42ab
1989	74	95.09±0.32f	10.67±0.39ab	45.03±1.24ab	77.91±0.31 h		
1990	77	98.37±0.32abc	10.69±0.39ab	46.80±1.22ab	80.16±0.31cdef		
1991	83	99.53±0.31a	11.16±0.37ab	47.06±1.18ab	80.82±0.30bcd		
1992	80	98.87±0.31ab	10.87±0.38ab	47.01±1.20ab	81.70±0.30ab		
1993	92	97.55±0.29abcd	10.75±0.36ab	45.69±1.12ab	80.65±0.28bcd		
1994	83	97.74±0.31abcd	11.69±0.37a	46.02±1.18ab	80.01±0.30cdef		
1995	74	97.91±0.32abcd	10.61±0.39ab	46.78±1.24ab	79.90±0.31cdef		
1996	64	97.65±0.35abcd	10.82±0.42ab	45.77±1.33ab	79.69±0.34cdefg		
1997	83	97.69±±0.31abcd	10.59±0.37ab	45.42±1.17ab	78.50±0.29 gh		
1998	77	97.64±0.32abcd	10.66±0.38ab	46.43±1.21ab	79.21±0.30efg		
1999	83	97.08±0.30cde	10.56±0.37ab	45.59±1.16ab	78.87±0.29fgh		
2000	67	96.99±0.34cde	10.55±0.41ab	45.46±1.29ab	80.90±0.33bc		
2001	83	97.78±0.30abcd	10.86±0.37ab	46.04±1.16ab	80.16±0.29cdef	34	69.16±0.52ab
2002	91	96.76±0.29de	10.65±0.35ab	45.84±±1.11ab	79.52±0.28 defg	60	70.30±0.41a
2003	95	97.46±0.28bcd	11.57±0.34a	45.47±1.09ab	79.27±0.27efg		
2004	79	94.78±0.31f	9.98±0.38ab	50.10±1.20a	82.22±0.30a		
2005	91	93.17±0.29 g	10.01±0.35ab	43.03±1.11b	80.25±0.28cde		
2006	103	93.37±0.27 g	9.53±0.33b	43.11±1.04b	80.60±0.26bcd		
2007	92	93.26±0.29 g	9.58±0.35b	43.10±1.10b	80.67±0.28bcd		
Sex of foal		***	ns	*	*		ns
Filly	831	96.35±0.10b	10.48±0.13	45.22±0.40b	79.88±0.10b	105	68.80±0.30
Colt	850	96.97±0.10a	10.78±0.13	46.27±0.40a	80.23±0.10a	98	69.27±0.31
Overall mean	1681	96.66±0.08	10.63±0.10	45.74±0.31	80.05±0.08	203	69.03±0.23

Cannon bone circumference at birth changed from 9.53±0.33 at 2006 to 11.69±0.37 at 1994. Foaling age and foaling years and sex of foal on birth weight was significant ($p<0.001$-0.05). Birth weight was the the shortest at 42.72±0.83 in 5 years of age dams and the highest at 49.83±1.03 in 12 years of age dams. Although, effect of foal sex on body length at birth was insignificant, effects of foaling year, month and age on body length were significant ($p<0.001$-0.05). Effect of foaling year, age of mares and sex of foals on Heart girth was significant ($p<0.001$-0.05). From 1681 birth measurements. The least square means for withers height, cannon bone circumference, birth weight, heart girth and body length were 96.66±0.08, 10.63±0.10, 45.74±0.31, 80.05±0.08 and 69.03±0.23 cm, respectively. These data at birth correspond to those reported by Koç (1990) and Altinel and Kucuk (1992).

Under modern horse management, foals are weaned at a much younger age, usually 4-6 months (Houpt et al. 1984). In this farm, foals were weaned at 6 months of age. The least square means of withers height, cannon bone circumference and heart girth and body length at 6 month of age foals were presented in Table 2.

Effect of foaling month and foaling year on withers height at 6 month of age were statistically very significant ($p<0.001$-0.05).Withers height was the shortest at April at 135.37±0.46 cm and the highest at 136.84±0.64 at January. Withers height was the shortest at 125.95±1.18 at 2000 and the highest at 153.68±0.84 at 2005. Effects of foaling age and foaling year on cannon bone circumference at

Table 2: The least square means of withers height, cannon bone circumference, and heart girth and body length at 6 month of age foals (at weaning)

Factors	n	Wither height	Cannon bone circumference	Heart girth	n	Body length
Age		ns	*	ns		ns
5	19	137.19±0.85	16.54±0.16ab	148.45±1.20	16	121.41±0.90
6	24	135.17±0.77	16.36±0.15ab	146.13±1.09	12	120.75±1.03
7	27	135.63±0.70	16.47±0.13ab	147.56±0.99	16	121.81±0.86
8	25	136.98±0.71	16.78±0.14ab	148.80±1.01	14	122.73±0.94
9	25	136.36±0.74	16.82±0.15ab	148.12±1.04	15	122.68±0.92
10	14	136.43±0.94	16.58±0.18a	147.50±1.33	9	122.59±1.16
11	20	136.66±0.80	16.81±0.15ab	148.42±1.30	10	122.40±1.09
12	17	136.31±0.92	16.85±0.17a	148.89±1.30	10	121.89±1.11
13	11	136.47±1.06	16.93±0.21a	148.58±1.50	7	122.39±1.30
14	14	136.08±0.95	16.76±0.18ab	149.28±1.34	9	122.88±1.15
15	14	135.22±±0.91	16.16±0.17ab	148.53±1.28	7	121.50±1.27
16	20	136.67±0.81	16.76±0.15ab	149.65±1.14	15	122.59±0.88
17	18	137.26±0.84	16.69±0.16ab	148.13±1.23	14	122.10±0.98
18 and older	20	135.63±0.83	16.48±0.16ab	146.26±1.18	9	120.44±1.16
Month		ns	ns	***		ns
1 (January)	35	136.84±0.64	16.75±0.12	149.84±0.90a	16	121.63±0.95
2 (February)	62	136.80±0.49	16.65±0.09	148.93±0.70ab	40	122.85±0.58
3 (March)	81	136.78±0.45	16.78±0.09	149.90±0.64a	46	122.63±0.51
4 (April)	80	135.37±0.46	16.63±0.09	146.74±0.65c	56	121.32±0.45
5 (May)	10	135.66±1.14	16.40±0.22	145.42±1.61c	5	121.63±1.56
Year		***	***	***		***
2000	10	125.95±1.18f	15.10±0.22e	140.64±1.66cd		
2001	73	130.47±0.45e	16.58±0.09c	137.67±0.64d	73	119.92±0.49 b
2002	90	126.83±0.43f	15.56±0.08d	142.84±0.60c	90	124.10±0.47 a
2004	39	139.68±0.58c	17.56±0.11b	152.53±±±.82b		
2005	19	153.68±0.84a	19.28±0.16a	172.80±1.19a		
2006	23	142.93±0.75b	17.19±0.14b	152.52±1.05b		
2007	14	134.48±1.00d	15.22±0.19d	138.15±1.41d		
Sex of foal		ns	ns	ns		ns
Filly	122	135.97±0.41	16.57±0.08	148.08±0.58	77	121.99±0.46
Colt	146	136.61±0.40	16.71±0.08	148.25±0.57	86	122.04±0.49
Overall mean	268	136.30±0.34	16.64±0.06	148.16±0.48	163	122.01±0.39

6 month of age were significant ($p<0.001$-0.05). Effects of foaling month and foaling year on heart girth at 6 month of age were significant ($p<0.001$). Effects of foaling year on body length only was statistically significant ($p<0.001$). From 268 data, the least square means of withers height, cannon bone circumference and heart girth and body length at 6 month of age foals were 136.30±0.34, 16.64±0.06, 148.16±0.48 and 122.01±0.39. These values at 6th month were higher than those reported by Koç (1990) and Koç and Altinel (1992).

The least square means of withers height, cannon bone circumference, body length and heart girth at 1 year of age foals were presented in Table 3. Effects of foaling month and foaling year on withers height, cannon bone circumference and heart girth were significant ($p<0.001$). Effects of sex of foals on Cannon bone circumference was significant ($p<0.001$). Effect of foaling age of mares on all traits (withers height, cannon bone circumference, body length and heart girth) was insignificant ($p>0.05$). Effects of all factors (age of mares, foaling age, foaling month, sex of foals) on body length were insignificant ($p>0.05$). From 422 data, the least square means of withers height, cannon bone circumference and heart girth and body length at 1 years of age foals were 142.18±0.42, 17.73±0.04, 156.696±0.36 and 132.08±0.86. These values at 1 years of age were higher than those reported by Özdemir (1998).

The least square means of withers height, cannon bone circumference, heart girth and body length at 2 years of age foals were presented in Table 4. Effect of foaling year on all traits (withers height, cannon bone circumference, body length and heart girth) was significant ($p<0.001$-0.05). Effects sex of foal on cannon bone circumference and wither height were significant ($p<0.001$-0.05). Effects of foaling month and foaling age on all traits were insignificant ($p>0.05$). From 160 data, the least square means of withers height, cannon bone circumference and heart girth and body length at 2 years of age foals were 149.80±0.37, 18.82±0.08, 170.96±0.54 and 142.04±0.46. These values at 2 years of age were higher than reported in literature (Özdemir, 1998; Dogan *et al*., 2002).

Body measurement values in this study were higher than values of native horses in Turkey reported by Bayram *et al*. (2005). Also and Body measurement values in this study were higher than values of Icelandic toelter horses (Árnason and Bjarnason, 1994) and native Žemaitukai horse (Macijauskiene and Juras, 2003).

The least square means of withers height, cannon bone circumference, heart girth and body length at 3 years of age foals was presented in Table 5. Effect of foaling month on cannon bone circumference was significant ($p<0.05$). From 160 data, the least square means of withers

Table 3: The least square means of withers height, cannon bone circumference, heart girth and body length at one years of age foals

Factors		Withers height	Cannon bone circumference	Heart girth	n	Body length
Age		ns	ns	ns		ns
5	42	141.45±1.14	17.75±0.10	155.87±0.97	8	135.27±1.88
6	40	141.34±1.17	17.79±0.10	155.13±0.99	7	132.79±1.95
7	38	141.79±1.18	17.74±0.10	155.67±0.99	6	134.81±1.99
8	48	141.40±1.07	17.49±0.09	154.39±0.90	8	133.85±1.85
9	30	143.08±1.31	17.76±0.11	157.69±1.11	9	133.68±1.80
10	27	142.72±1.38	17.77±0.12	156.92±1.11	8	133.36±1.89
11	24	143.17±1.48	17.65±0.12	156.76±1.25	6	132.89±2.02
12	22	141.99±1.54	17.76±0.13	155.69±1.30	6	133.66±2.03
13	27	144.49±1.39	18.00±0.12	159.56±1.17	6	134.06±1.81
14	30	138.44±1.31	17.66±0.11	157.91±1.11	3	129.99±2.54
15	21	141.58±1.57	17.64±0.13	155.41±1.32	9	131.69±1.48
16	18	143.15±1.77	17.81±0.15	157.54±1.49	11	133.17±1.61
17	21	142.99±1.53	17.60±0.13	157.88±1.29	4	132.10±2.58
18 and older	34	143.06±1.27	17.79±0.11	157.35±1.07	0	129.63±4.09
Month		***	***	***		ns
1 (January)	56	144.11±0.97a	17.86±0.08ab	159.58±0.82a	14	133.41±1.55
2 (February)	133	143.64±0.63a	17.96±0.05a	159.29±0.54a	43	134.94±1.21
3 (March)	117	144.15±0.71a	17.84±0.06ab	157.37±0.60ab	32	134.33±1.10
4 (April)	85	141.82±0.81a	17.60±0.07ab	155.39±0.68b	2	129.02±3.05
5 (May)	31	137.23±1.30b	17.39±0.11bc	151.87±1.10e	0	
Year		***	***	***		ns
1998	41	142.56±1.15bc	17.76±0.10 c	156.17±0.97cd		
1999	42	142.44±1.14bc	17.34±0.10de	153.40±0.96cde		
2000	39	137.79±1.19d	17.30±0.10e	151.26±1.00e	41	132.73±1.03a
2001	69	139.71±0.92cd	17.47±0.08cde	152.59±0.78cde	50	131.40±0.92b
2002	61	140.16±0.94cd	17.70±0.08cd	156.33±0.80 c		
2003	57	136.52±0.98d	17.32±0.08de	150.76±0.83e		
2004	28	151.19±1.37a	19.21±0.12a	174.42±1.16a		
2005	59	146.04±0.96b	18.27±0.08b	162.84±0.81b		
2006	26	143.30±1.43bc	17.19±0.12e	152.53±1.21de		
2007						
Sex of foal		ns	***	ns		ns
Filly	217	141.95±0.55	17.58±0.05b	157.02±0.46	43	132.77±1.41
Colt	205	142.42±0.55	17.88±0.05a	156.38±0.46	48	133.08±1.35
Overall mean	422	142.18±0.42	17.73±0.04	156.70±0.36	91	132.08±0.86

height, cannon bone circumference and heart girth and body length at 3 years of age foals were 151.79±0.78, 19.32±0.11, 175.33±0.99 and 145.1±1.00. These values at 3 years of age were nearly higher those reported in literature (Demirtel, 1975; Özdemir, 1998; Dogan *et al*., 2002).

Body measurements at birth correspond to literature (Koç, 1990; Altinel and Küçük, 1992) for Purebred Arabian foals. However, Body measurements at 6th month, 1st, 2nd and 3rd year was higher literature (Demirtel, 1975; Koç and Altinel, 1992; Özdemir, 1998; Dogan *et al*., 2002). These data demonstrate that growth of foals after birth was better in Anadolu state farm. As reported by Hintz *et al*. (1979). Foals born in February, March, April, May, or June were heavier than foals born in January.

The average values for withers height of colts and fillies at birth, 6 month, 1, 2 and 3 years of age were 96.66±0.08, 136.29±0.34, 142.18±0.42, 149.80±0.37 and 151.79±0.78 cm, respectively. Average values heart girth were80.06±0.08,148.16±0.48,156.70±0.36,170.96±0.54and 175.33±0.99 cm, respectively. The average values for body length foals at birth, 6th month, 1 years of age, 2 years of age and 3 years of age were, respectively 69.03±0.23, 122.01±0.39, 132.08±0.86, 142.04±0.46, 145.08±1.00. Averages values for cannon bone circumference were 10.63±0.10,16.64±0.07,17.73±0.04,18.82±0.08,19.32±0.11, respectively.

Effect of age of mare on body measurements at birth was significant ($p<0.001$), except for cannon bone circumference. Body measurements and weight at birth were lowest at 5 years of age mares. It can be said that birth weight increases to 12 years of age, then it decrease after 12 years of age. It may be caused by material (uterine) environment. Lower body measurement and birth weight for foaling mares at 5 years of age may be associated with that reproductive organs are not completely mature. Lower body measurement and birth weight in older mares (18>) may be associated with degenerative endometrial changes.

Effect of foaling month on body measurement and birth weight was insignificant except for withers height. Except for cannon bone circumference, effect of sex of foals on body measurement and weight was significant. Differences of birth weight may be by caused attention and feeding differences among years. At birth, all body measurements for colts were higher than measurements for fillies. Growth of colts rapidly in uterine may be caused testosterone hormone which stimulates growth of foals.

Table 4: The least square means of withers height, cannon bone circumference, heart girth and body length at 2 years of age foals

Factors	n	Withers height	Cannon bone circumference	Heart girth	n	Body length
age	ns	ns	ns	ns	ns	
5	16	150.76±0.78	19.00±0.17	172.40±1.15	7	142.9±1.33
6	15	150.25±0.84	18.99±0.19	169.76±1.24	6	142.5±1.46
7	11	148.96±0.91	18.88±0.20	170.55±1.35	3	141.7±2.09
8	12	150.33±0.93	18.96±0.21	170.34±1.38	6	140.7±1.43
9	11	149.50±0.94	18.83±0.21	170.72±1.40	6	141.5±1.38
10	18	149.48±0.75	18.81±0.17	171.63±1.11	8	142.5±1.24
11	8	149.59±1.11	18.72±0.25	170.65±1.65	5	141.5±1.59
12	11	150.35±0.92	18.84±0.20	173.05±1.37	4	144.8±1.79
13	8	151.76±1.06	18.86±0.24	172.66±1.58	5	143.8±1.52
14	12	148.94±0.89	18.64±0.20	169.30±1.32	8	142.0±1.18
15	15	150.02±0.80	18.66±0.18	169.27±1.18	10	142.2±1.10
16	13	148.80±0.90	18.48±0.20	170.40±1.33	6	141.5±1.43
17	5	149.69±1.31	18.75±0.29	169.68±1.95	3	138.9±1.91
18 and older	5	148.79±1.34	19.09±0.30	173.04±1.98	0	
Foaling month	ns	ns	ns		ns	
1 (January)	29	148.91±0.63	18.90±0.14	171.27±0.93	18	143.1±0.86
2(February)	50	149.99±0.47	18.79±0.10	171.77±0.70	26	142.3±0.80
3 (March)	44	150.68±0.54	18.92±0.12	170.95±0.80	19	142.5±0.99
4 (April)	30	149.28±0.62	18.69±0.14	169.91±0.92	14	140.2±1.05
5 (May)	7	150.14±1.17	18.81±0.26	170.90±1.74	0	
Year		***	*	***		*
1997	15	149.54±0.83 c	18.44±0.18 b	166.43±1.23 d		
1998	11	149.53±0.97 c	18.95±0.22 ab	173.62±1.44 ab		
1999	22	148.76±0.73 c	18.81±0.16 ab	168.08±1.08 d	22	144.8±1.01 a
2000	36	147.43±0.57 c	18.69±0.13 ab	168.33±0.85 d	34	141.7±0.65 b
2001	32	148.26±0.56 c	18.68±0.12 ab	169.82±0.83 cd	21	139.6±0.83 b
2002	8	149.28±1.14 c	19.10±0.25 a	169.46±1.69 cd		
2003	10	149.73±0.95 bc	18.77±0.21 ab	174.57±1.41 a		
2004	22	152.91±0.70 a	19.20±0.16 a	174.44±1.04 a		
2005	4	152.77±1.50 b	18.75±0.33 ab	173.91±2.22 ab		
Sex of foal		*	***	ns	ns	
Filly	47	149.18±0.55 b	18.45±0.12 b	170.29±0.81	27	142.4±0.78
Colt	113	150.42±0.35 a	19.19±0.08 a	171.63±0.52	50	141.7±0.50
Overall mean	160	149.80±0.37	18.82±0.08	170.96±0.54	77	142.04±0.46

Table 5: The least square means of withers height, cannon bone circumference, heart girth and body length at three years of age foals

Factors	n	Withers height	Cannon bone circumference	Heart girth	n	Body length
Age		ns	ns	ns		ns
5	3	155.67±2.23	19.84±0.32	176.88±2.08	3	145.9±2.22
6	3	151.45±2.01	19.53±0.29	172.89±2.57	3	144.3±2.06
7	2	150.37±2.81	19.37±0.41	177.13±3.58	2	146.1±2.72
8	4	153.71±1.92	19.60±0.28	173.12±2.44	3	144.5±2.30
9	5	149.17±1.61	18.86±0.23	176.08±2.05	3	144.8±2.23
10	2	150.50±2.52	18.44±0.37	174.48±3.21	2	145.9±2.55
11	2	152.26±2.56	19.78±0.37	177.16±3.27	2	143.9±2.53
13	3	151.79±2.16	19.55±0.31	173.12±2.75	3	146.7±2.21
14	5	150.83±1.44	19.37±0.21	177.07±1.83	4	145.0±1.82
15	4	151.23±1.87	19.16±0.27	175.96±2.38	4	144.2±1.96
16	4	152.71±1.72	19.06±0.25	174.72±2.20	3	144.5±1.92
Month		ns	*	ns		ns
1 (January)	8	153.09±1.30	19.57±0.19 ab	175.55±1.65	8	145.5±1.27
2 February)	9	149.43±1.46	18.82±0.21 c	173.96±1.86	9	145.7±1.56
3 (March)	13	150.80±1.43	19.06±0.21 bc	176.45±1.82	9	144.7±1.81
4 (April)	7	153.85±1.81	19.84±0.26 a	175.35±2.30	6	144.4±1.95
5 (May)						
Year		ns	ns			ns
1999	11	150.81±1.55	19.02±0.23	173.79±1.97	11	146.8±1.54
2000	19	151.44±0.93	19.38±0.14	175.02±1.19	19	146.4±0.91
2001	7	153.12±1.67	19.57±0.24	177.18±2.12	2	142.0±2.73
Sex of foal		ns	ns	ns		ns
Filly	12	151.46±1.40	19.09±0.20	176.44±1.78	12	145.2±1.52
Colt	25	152.13±0.79	19.55±0.12	174.21±1.01	20	145.0±1.04
Overall mean	37	151.79±0.78	19.32±0.11	175.33±0.99	32	145.1±1.00

At weaning or 6 month of age, measurements of born foals in January, February and March was higher than measurements of born foals in April and May. Born foals in April and May are 6 month of age at winter. Because of bad nutritive resources and insufficient feeding in autumn, born foals in April and May have low body

measurement. Born foals in January, February and March are 6 month of age at summer. Born foals in January, February and March have high body measurement because of availability of green fodder during the spring and summer. Difference among colts and fillies was insignificant at 6 month of age. Although, sex of foals on body measurements was insignificant, it was found that males generally have greater body measures than females, in agreement with (Özdemir, 1998).

In this study, growth traits of purebred Arabian foals under the conditions of Anadolu State farm was higher than those reported in the literature (Demirtel, 1975; Koç, 1990; Altinel and Küçük, 1992; Koç and Altinel, 1992; Özdemir, 1998; Dogan *et al*., 2002).

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CONCLUSION

The results of this study have shown that the under the conditions of Anadolu state farm purebred Arabian foals perform well in respect of growth traits is higher than those reported in the literature (Demirtel, 1975; Koç, 1990; Altinel and Küçük, 1992; Koç and Altinel, 1992; Özdemir, 1998; Dogan *et al*., 2002). It can be concluded that purebred Arabian foals are raised successfully for growth traits on Anadolu state farm and under steppe climate conditions in Turkey. It is concluded that better growth performance levels can be obtained by culling foals with low body measurement, by selecting foals with high body measurement and by better feeding and attention of foals. Mean values of body measurement in this study can be used to control growth of foals in this farm at some periods (birth, 6 month, 1, 2 and 3 year) and growth performance of foals was evaluated according to these values.

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