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The Survey of Reproductive Success in Arabian Horse Breeding from 1976-2007 at Anadolu State Farm in Turkey

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Abstract: The aim of this study, was to determine the level of some important production characteristics and to investigate some environmental factors affecting fertility traits of purebred Arabian mares raised at Anadolu state farm in Eskisehir for last 30 years. This study was carried out on the data obtained from 2189 mares for fertility traits between 1976 and 2006. The least square means of gestation length, first servicing period, service period, foaling interval, oestrus cycle per pregnancy and NIPC was 334.3±0.22, 24.91±0.93, 45.12±1.09 and 371.79±1.57 days, 1.53±0.03, 5.68±0.10, respectively. Heritability of gestation duration was estimated 0.22±0.06 by paternal half sib method from 2093 gestation duration of purebred Arabian mares sired by 49 stallion, which had at least 5 daughters. It can said that effect of environmental factors on gestation duration is higher than genetic factors. The average gestation length was estimated as 334.3±0.22 days for Arabian mares. Effects of foal sex, breeding age, breeding month and breeding year were significant ($p<0.001$-0.05). Colt foal pregnancies were longer than fillies. Gestation duration increased with age up to maturity and decreased thereafter. Shortest gestation duration was found in mares bred in June. Although, the effect of breeding month on first servicing period was insignificant ($p>0.05$), effect of breeding month on service period, on foaling interval, on oestrus cycle per pregnancy and on Number of Insemination for Per Conception (NIPC) was significant ($p<0.001$). Although, effect of breeding year on oestrus cycle per pregnancy was insignificant ($p>0.05$), effect of foaling year on first servicing period, on service period, on foaling interval and on NIPC was significant ($p<0.001$-0.05). On the basis of mares at mating oestrus, from fertility records of 3223 mares, ratios of oestrus, sub-oestrus, pregnancy, sterility, parturition and abortion were 98.70, 1.30, 74.00, 26.00, 69.07 and 4.93% for Arabian mares, respectively. As ratio of parturition was >80% after 2000 year, it can be concluded that reproductive performance of Arabian horses are higher after 2000 year. The factors have the greatest influence over the fertility traits were the breeding month of mares and breeding year. Better performance levels can be obtained by culling old, emphysema pulmonum and infertile mares and better feeding and attention. Oestrus detection and artificial insemination should be performed at the right time and in an appropriate way. An appropriate teasing technique should practice in deciding whether mares are properly in heat. Controls of ovulation and gestation examination by using ultrasonography should be done.

Key words: Arabian horse, purebred, environmental factors, fertility traits, performance

INTRODUCTION

In Arabian horse breeding, Turkey is one of the most famous countries in world. Arabian horse has been bred in Arabian half island and Turkey since 2000 years before christ. Moreover, In origine and breeding of first Throughbred horses, a lot of Turk Arabian stallios in Turkey were used, for example, Byerler Turk (Arpacik, 1994).

Horses have developed many strategies for seasonal breeding that ensure that their offspring is born at the appropriate time of the year. The horses are seasonal polyestreous species with onset of the breeding season occuring in spring, associated with increase in daylight, temperature and availability of food. The breeding season in Turkey occurs from february to July, resulting in the same official age for all foals born the same season (Nagy *et al*., 2000). Fertility of mares can be affected by many factors, some genetic, others environmental. Environmental factors can be classified as factors with measurable effects (age, parity, foaling year, breeding season, 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 stud farm (Yalcin, 1975; Cilek, 2008a, b).

In Arabian horse, number of oestrus cycle were reported between 1.24 and 1.50 and service number per gestation reported between 2.98 and 5.8 (Kucuk, 1990; Koc and Altinel, 1992; Ozdemir, 1998). On the base of mares at mating, conception rate were reported between 66.28 and 87.73% (Koc and Altinel, 1992; Yurdaydin and Sevinc, 1983; Kucuk and Altinel, 1992; Ozdemir, 1998). Foaling rate for Arabian were reported between 52 and 84.1% (Koc and Altinel, 1992; Yurdaydin and Sevinc, 1983; Ozdemir, 1998; Tischner, 2002; Schulman *et al*., 2003). It was stated that the ratios of abortion was between 1.86 and 9.2% for Arabian mares (Koc and Altinel, 1992; Ozdemir, 1998; Tischner, 2002; Schulman *et al*., 2003). Most of foals were aborted before reaching 5-6 months of age (Tischner, 2002). Allen *et al*. (2007) reported that early, middle and late pregnancy loss rates were 7.2% vs. 8.0% (15-42 Days), 3.6% vs. 6.1% (Days 42-1st October) and 2.7% vs. 2.1% (October-foaling), respectively. Hemberg *et al*. (2004) reported that age of the mares had a significant influence on the live foal rate, being lower for mares 13 years of age and older and resorption and abortion occurred in higher percentages among mares 8 years of age and older. Older mares than 12 years of age are less likely to be in foal at the end of a breeding season compared to younger mares because of early pregnancy loss (Staun *et al*., 1982; Buiten *et al*., 2003). Cacic *et al*. (2002) reported that conception rate was highest in May and lowest in January, as a consequence, foaling rate is highest in April.

Ball (1988) reported that incidence of embryonic loss in normal mares between fertilization and Day 50 was approximately 18% but in subfertile mares, the corresponding estimate for embryonic loss between fertilization and Day 50 is 80%. The high rate of early embryonic loss in subfertile mares could be related to embryonic defects, oviductal environment, or uterine environment (Ball, 1988).

Kutluca (1995) reported that the lowest conception rates occurred in mares inseminated in February (74.6%) and the highest in March (86.1%). The conception and the foaling rates were highest in group of between 5 and 8 ages being 87.4 and 82.4%, respectively. These rates reduced as the age of mares increased being the lowest 70.7 and 62.3%, respectively in the mares older than 12 years of age (Kutluca, 1995). The accurate examination of reproductive tracts, appropriate teasing programmes and HCG administration before ovulation helps improve ovulation and fertility rates in Thoroughbred mares (Yaung *et al*., 2004).

The gestation length was reported between 332.84±0.81 and 336±0.5 days for Arabian mares (Demirci, 1988; Koc, 1990; Kucuk, 1990; Ozdemir, 1998). Heritability of gestation duration for Arabian mares was reported between 0.16 and 0.36 (Rollins and Howell, 1951; Taveira and Silveira, 2007). As effect of environmental factors on gestation duration is higher than effect of genetic factors, environmental factors affecting on gestation duration were known well.

Sevinga *et al*. (2004) reported that pregnancies were shorter when conception occurred in July, coinciding with maximum photoperiod oscillations. It was reported that gestation length was longer when mares gave birth to colts rather than fillies (Akkayan and Demirtel, 1973; Perez *et al*., 2003; Sevinga *et al*., 2004). The effects of the years on the gestation periods were not significant (Kutluca, 1995). It was reported that age of mares significantly influenced length of gestation (Demirci, 1988; Valera *et al*., 2006). It was reported younger fillies at first mating showed longer duration of pregnancy and negatively correlated with the mare's age (Cacic *et al*., 2002). Although, Demirci (1988) reported that there was a negative correlation between the age of mares and gestation lengths and young mares have longer gestation length than old mares, Valera *et al*. (2006) reported that gestation length decrease as the mare gets older, with the shortest gestation periods when the mare is 10-12 years old and from this point on, it slowly increases. It was reported that most of mares (81.2%) foaled at night and in pre-parturient woman and rhesus monkey, species that also preferentially deliver during the night and early morning hours, plasma oxytocin concentrations and uterine activity increased at night (Sevinga *et al*., 2004).

Kutluca (1990) reported that effect of foaling months on the service period was significant and mean values were 15.5 days in mares foaling in may and 38.6 days in mares foaling in February. Zeller (2000) reported that average first servicing period and servis period, which was very closely related to the average environmental temperature and also to the average air moisture in the puerperium, were 13.54±0.71 and 43.12±1.92 days, respectively and longer in January and in the coldest year. Staun *et al*. (1982) reported, it could be said that service period was the longer in the older mares than 12 years and increasing mare age may be associated with degenerative endometrial changes, incidence of acute endometrial and abnormal oocyte.

This study was conducted to investigate the environmental factors affecting fertility traits of purebred Arabian mares raised at Anadolu state farm in Eskisehir provience in Turkey.

MATERIALS AND METHODS

The breeding records of 2189 Arabian mares raised at Anadolu state farm in Eskisehir province between 1976 and 2006 were collected. Gestations lasting with alive birth

between 320 and 350 days was to be considered normal and was used calculation. Heritability of gestation duration was estimated by paternal half sib method from 2093 gestation duration of purebred Arabian mares sired by 49 stallion, which had at least 5 daughters.

Environmental factors which influenced first servicing period, service period, oestrus cycle per pregnancy, Number of Insemination for Per Conception (NIPC), foaling interval and gestation length were investigated. The General Linear Model (GLM) was used for variance analyses of fertility traits. Fourteen breeding age groups were formed beginning from 4 years and ending at 17 years and older for foaling age; 6 groups for foaling month between February and June and 31 groups for foaling year, between 1976 and 2006. Duncan's multiple range test was used for multiple comparisons. According to breeding year and age of mare, on the basic of mares at mating, oestrus, pregnancy, sterility, parturition and abortion ratios were calculated from breeding records of 3223 purebred Arabian mares.

RESULTS AND DISCUSSION

Variance analyze of heritability of gestation duration was presented in Table 1. Mean daughter number for each stallion (no) was found as 41.905. Total phenotypic variance (σ^2_f = 69.885) and between groups variance (σ^2_a = 3.885) were calculated by using mean squares within groups and between groups in Table 1, then correlation coefficient within bulls (t = 0,056) was calculated by dividing $t = \sigma^2_a / \sigma^2_f$. As heritability was 4t, heritability was found as 0.22. Standard deviation of correlation coefficient within groups (S_t = 0.0152) was estimated. This was multiplied by four and standard deviation of heritability ($S_h^2 = 4\ S_t$ = 0.06) was found. Heritability of gestation duration for Arabian mares was at low level and within the limits in the literature (Rollins and Howell, 1951; Taveira and Silveira, 2007). This value demonstrated that 88% of total (phenotypic) variance was environmental variance. As effect of environmental factors on gestation duration is higher than effect of genetic factors, environmental factors affecting gestation duration were known well.

Ariturk and Yalcin (1966) reported that heritability to be reliable, standard deviation of it should be smaller than half of it. Results in this study were accordance with this rule. So, in these results, quite large data set was used. Furthermore, to make calculations by paternal half sib correlation method reliable, all necessary conditions (selection of stallion by change, breeding in the same environmental factors, coefficient of relationship (there wasn't inbreeding in herd) were performed, as reported by Duzgunes *et al*. (1987).

Table 1: Variance analyze of gestation duration

Source	DF	Means of Squares (MS)	F
Between bulls	48	228.8	$\sigma^2_i + k\ \sigma^2_a$
Within bulls	2044	66.0	σ^2_i
Total	2092		
No	41.905		

Table 2: Least square means of gestation length (day)

Factors	n	Mean+SEM
Breeding age		***
4	220	335.9±0.58a
5	233	335.2±0.56ab
6	214	334.8±0.58ab
7	199	334.1±0.60ab
8	195	334.2±0.61ab
9	171	332.6±0.64b
10	156	332.4±0.67b
11	144	333.1±0.70ab
12	124	333.8±0.76ab
13	113	334.9±0.79ab
14	97	334.8±0.85ab
15	76	334.1±0.97ab
16	69	334.8±1.01ab
17 and older	178	335.9±0.64a
Breeding month		*
2 (February)	259	335.1±0.53a
3 (March)	692	335.1±0.33a
4 (April)	597	334.3±0.36ab
5 (May)	465	333.9±0.40ab
6 (June)	176	333.3±0.63b
Breeding year		***
1976	17	333.5±2.01bcd
1977	52	335.7±1.16abc
1978	49	334.7±1.18abcd
1979	66	335.4±1.02abc
1980	38	332.8±1.34cd
1981	40	332.2±1.31cd
1982	68	333.5±1.00bcd
1983	44	332.0±1.25cd
1984	40	333.3±1.31bcd
1985	51	332.6±1.16cd
1986	56	331.4±1.11d
1987	49	333.9±1.18bcd
1988	77	334.5±0.95abcd
1989	85	334.8±0.91abcd
1990	82	333.7±0.93bcd
1991	78	335.3±0.95abcd
1992	89	335.1±0.89abcd
1993	87	335.2±0.90abcd
1994	76	333.5±0.96bcd
1995	65	333.8±1.03bcd
1996	79	332.6±0.94cd
1997	77	333.3±0.95bcd
1998	81	335.6±0.92abc
1999	70	334.6±0.99abcd
2000	99	335.2±0.83abcd
2001	90	334.3±0.87bcd
2002	95	337.7±0.85a
2003	96	336.7±0.85ab
2004	98	335.2±0.84abcd
2005	104	336.3±0.81ab
2006	91	335.7±0.87abc
Sex of foal		***
Filly	1066	333.7±0.29b
Colt	1123	334.9±0.28a
Overall mean	2189	334.3±0.22

*:p<0.05; **:p<0.01; ***:p<0.001; ns: nonsignificant; SEM: Standard Error of the Mean, a,b,c:Means without a common superscript within each variable and each factor differ (p<0.05)

Least square means for gestation length are presented in Table 2. The average gestation length was estimated as 334.3±0.22 days for Arabian mares and within the limits in the literature (Demirci, 1988; Koc, 1990; Kucuk, 1990; Ozdemir, 1998). Effect of foal sex on gestation duration was significant ($p<0.05$). Gestation length was found the shortest in mares bred in June with 333.3 days and the highest in mares bred in February and March with 335.1 days.

On gestation duration, effects of breeding age, breeding year, breeding month and sex of foal were significant ($p<0.001$). The lowest gestation duration was found 332.4±0.67 days in mature age (10 years old mares). The highest gestation duration was found 335.9±0.58 days in the youngest (4 years old) the oldest mares (17 and older age). It can be said that gestation duration decreases with age up to maturity and increases with age thereafter. As informed by Valera *et al.* (2006), gestation length decreased from 4 years old to 10 years old and from this point on, it slowly increased.

The lowest gestation duration was found 331.4±1.11 days in 1986. The highest gestation duration was found 337.7±0.85 days in 2002. Gestation duration of mares gave birth to colts was 334.9±0.28 days. Gestation duration of mares gave birth to fillies was 333.7±0.29 days. As reported previously (Akkayan and Demirtel, 1973; Perez *et al*., 2003; Sevinga *et al*., 2004), gestation length was longer when mares gave birth to colts rather than fillies. This may be ascribed differences to sex chromosome linked effects and testosterone hormone.

Effect of breeding year on gestation length was found statistically significant ($p>0.001$). It could be said that differences of management (attention and feeding) among years affected gestation duration. As reported that previous research (Perez *et al*., 2003; Cilek, 2008a, b), longer gestation duration in some years may be influenced deficient feeding and very cold years leading to a later end of gestation as a mechanism for adjusting to adverse climatic and nutrition conditions. As gestation duration decreased from January to June, it can be said gestation duration decreases with increasing of photoperiod. As reported in previous studies (Perez *et al*., 2003; Sevinga *et al*., 2004; Cilek, 2008a, b), gestation length was the shortest in mares bred in June (later in the reproductive season), when photoperiod was maximum. This natural adaptative mechanism allows the newborn foal access to the best nutritive and environmental resources in spring.

The least square means of first servicing period, service period, foaling interval, oestrus cycle per pregnancy and NIPC were presented in Table 3. Although, the effect of breeding month on first servicing period was insignificant ($p>0.05$), the effect of breeding month on service period, foaling interval, oestrus cycle per pregnancy and NIPC was significant ($p<0.001$). Service period was shortest in March at 30.90±1.60 days and service period was higher in June at 76.43±2.84 days. Average first servicing period, service period and foaling interval, NIPC and oestrus cycle per pregnancy were 24.91±0.93, 45.12±1.09 and 371.79±1.57 days, 5.68±0.10, 1.53±0.03, respectively. Because of negative effect of increasing environmental heat on fertility, oestrus cycle per pregnancy and NIPC was the lowest in February and 1.05±0.08 and 3.83±0.23, respectively. Oestrus cycle per pregnancy and NIPC was the highest in June and 2.33±0.09 and 8.82±0.25, respectively. Foaling interval was the highest at 393.88±4.10 days in June and the lowest at 357.23±2.31 days in March.

Effects of breeding age on first servicing period, service period, foaling interval, oestrus cycle per pregnancy and NIPC were insignificant ($p>0.05$). Service period was the lowest in 6 years old age at 40.21±2.56 days and the highest in 16 years old age at 49.93±4.63 days.

Although, effect of foaling year on oestrus cycle per pregnancy was insignificant ($p>0.05$), effect of foaling year on first servicing period, service period, foaling interval and NIPC was significant ($p<0.001$-0.05). First servicing period was the highest at 36.917±3.5068 days in 1990 and the lowest at 13.132±4.9553 days in 1978. Service period was the highest at 60.36±4.19 days in 1991 and the lowest at 34.03±9.39 days in 1977. Foaling interval was the highest at 387.00±6.05 days in 1991 and the lowest at 354.94±7.93 days in 1987. NIPC was the highest at 8.75±0.32 in 2004 and the lowest at 4.09±0.53 in 1985.

Although, the lowest service period was reported in May (Kutluca, 1995; Cacic *et al*., 2002) and in April (Cilek, 2008a, b), in this study, lowest service period was in March as 30.90±1.60 days. Although, effect of breeding month on service period was insignificant, service period in March was lower the other months. Mares breeding in March were easily pregnant may result from effect of appropriate temperature, humidity and availability of green fodder during the spring which might be favourable for the physiological functioning of different systems.

In this study, the longest service period was June as 76.43±2.84 days. As reported in previous researches (Zeller, 2000; Cilek 2008a, b), the longest service period and foaling interval were in mares foaling in June. Mares foaling in June couldn't have a chance for gestation in later in the reproductive season. As these mares will be mated in next breeding season, service period will be

Table 3: The least square means of first servicing period, service period, foaling interval and NIPC of mares

Factors	n	First servicing period (day) Mean+SEM	Service period (day) Mean+SEM	Foaling interval (day) Mean+SEM	NIPC Mean+SEM	Oestrus cycle per pregnancy
Age		ns	ns	ns	ns	ns
5	193	25.42±2.18	44.83±2.56	375.67±3.70	5.88±0.23	1.48±0.08
6	188	21.64±2.17	40.21±2.56	363.23±3.60	5.78±0.23	1.44±0.08
7	179	22.88±2.24	40.46±2.63	368.75±3.79	5.34±0.23	1.43±0.08
8	171	24.90±2.31	43.42±2.72	368.57±3.92	5.36±0.24	1.44±0.08
9	153	27.67±2.39	45.24±2.82	371.84±4.06	5.86±0.25	1.50±0.09
10	128	25.38±2.62	45.42±3.08	372.98±4.44	5.81±0.28	1.74±0.09
11	124	23.62±2.66	45.91±3.13	375.88±4.52	5.85±0.28	1.55±0.10
12	114	25.56±2.77	47.65±3.26	369.36±4.71	5.86±0.29	1.57±0.10
13	94	28.62±3.04	49.85±3.57	383.49±5.15	5.71±0.32	1.59±0.11
14	87	24.93±3.15	45.71±3.71	372.52±5.35	5.50±0.33	1.50±0.11
15	71	25.41±3.51	47.64±4.12	368.70±5.95	5.22±0.37	1.54±0.13
16	55	27.79±3.94	49.93±4.63	374.90±6.68	6.07±0.41	1.59±0.14
17 and older	146	20.06±2.48	40.33±2.91	367.41±4.20	5.70±0.26	1.51±0.09
Month		ns	***	***	***	***
2 (February)	182	28.39±2.23	32.44±2.62c	363.80±3.78bc	3.83±0.23 d	1.05±0.08c
3 (March)	525	23.98±1.36	30.90±1.60c	357.23±2.31c	4.25±0.14 d	1.16±0.05bc
4 (April)	466	23.48±1.43	37.73±1.68c	368.89±2.43b	5.16±0.15 c	1.36±0.05bc
5 (May)	383	23.67±1.54	48.10±1.81b	375.17±2.62b	6.37±0.16 b	1.75±0.06ab
6 (June)	147	25.04±2.42	76.43±2.84a	393.88±4.10a	8.82±0.25 a	2.33±0.09a
Year		***	*	*	***	ns
1976	9	34.04±9.59ab	43.75±11.27ab	377.35±16.27abcde	4.27±1.01h	1.19±0.35
1977	13	14.39±7.99c	34.03±9.39b	366.27±13.55defgh	6.62±0.84bcde	1.52±0.29
1978	34	13.13±4.96c	37.22±5.82b	371.01±8.41bcdef	7.41±0.52abc	1.64±0.18
1979	49	25.97±4.14abc	49.80±4.87ab	383.77±7.02ab	6.18±0.43bcdef	1.44±0.15
1980	30	18.35±5.26abc	42.02±6.19ab	369.10±8.93cdefg	6.24±0.55bcdef	1.46±0.19
1981	25	13.87±5.76c	43.94±6.77ab	373.76±9.77bcdef	6.73±0.61bcd	1.46±0.21
1982	41	19.13±4.49abc	36.40±5.28b	363.45±7.62gfh	5.99±0.47bcdefgh	1.42±0.16
1983	37	26.04±4.76abc	49.03±5.59ab	377.64±8.07abcde	7.54±0.50ab	1.48±0.17
1984	36	28.97±4.82abc	45.38±5.67ab	376.70±8.18abcde	4.51±0.51fgh	1.32±0.17
1985	33	28.03±5.06abc	50.13±5.95ab	370.36±8.58cdefg	4.09±0.53h	1.64±0.18
1986	40	30.14±4.57abc	51.06±5.38ab	377.91±7.76abcde	5.79±0.48bcdefgh	1.65±0.17
1987	38	19.79±4.67abc	39.24±5.49ab	354.94±7.93h	6.01±0.49bcdefgh	1.56±0.17
1988	45	23.34±4.32abc	44.03±5.08ab	373.23±7.33bcdef	5.38±0.45defgh	1.52±0.16
1989	60	19.18±3.76abc	38.17±4.42ab	369.40±6.38cdefg	5.35±0.40defgh	1.47±0.14
1990	70	36.92±3.51a	54.93±4.12ab	381.26±5.95abc	4.90±0.37defgh	1.43±0.13
1991	68	35.58±3.57ab	60.36±4.19a	387.00±6.05a	5.33±0.37defgh	2.07±0.13
1992	71	25.19±3.47abc	43.15±4.08ab	371.14±5.89bcdef	5.12±0.36defgh	1.54±0.13
1993	70	27.14±3.50abc	47.28±4.12ab	375.64±5.94abcde	4.84±0.37defgh	1.57±0.13
1994	73	25.65±3.43abc	45.33±4.03ab	356.81±5.81abcde	4.91±0.36defgh	1.44±0.12
1995	56	27.99±3.87abc	50.79±4.55ab	370.63±6.57cdefg	4.83±0.41defgh	1.50±0.14
1996	61	30.86±3.71abc	51.44±4.36ab	378.32±6.30abcd	4.90±0.39defgh	1.57±0.13
1997	75	28.82±3.36abc	47.39±3.94ab	361.04±5.69gfh	5.54±0.35cdefgh	1.57±0.12
1998	59	26.27±3.76abc	48.02±4.41ab	373.80±6.37bcdef	4.72±0.39efgh	1.57±0.14
1999	50	30.90±4.07abc	44.89±4.79ab	374.25±6.91abcdef	4.56±0.43fgh	1.37±0.15
2000	66	27.30±3.54abc	43.81±4.17ab	376.46±6.01abcde	4.97±0.37defgh	1.51±0.13
2001	78	21.89±3.27abc	39.64±3.85ab	364.45±5.56efgh	4.50±0.34fgh	1.51±0.12
2002	79	25.15±3.26abc	47.42±3.83ab	381.60±5.53abc	5.30±0.34defgh	1.70±0.12
2003	88	16.37±3.09c	37.62±3.64b	357.71±5.25gh	7.06±0.33abc	1.68±0.11
2004	92	25.86±3.01abc	46.76±3.54ab	366.55±5.11defgh	8.75±0.32a	1.64±0.11
2005	85	20.06±3.15abc	39.57±3.70ab	369.51±5.34cdefg	7.55±0.33ab	1.49±0.11
2006	72	25.99±3.40abc	46.21±3.99ab	374.52±5.77abcdef	6.38±0.36bcdef	1.49±0.12
Overallmean	1703	24.91±0.93	45.12±1.09	371.79±1.57	5.68±0.10	1.53±0.03

longer. Mares foaling early may have both more chance for gestation in reproductive season and an age advantage over foals born the same season. Therefore, a profitable horse breeding could be possible by foaling before March (earlier in the reproductive season). Artificial photoperiod, simulating long days, can be used to advance the time of the first ovulation of the year in mares in this farm.

Although, effect of mare age on service period was insignificant, it can be said that service period is generally the longer in the older mares than 12 years, which is similar to Staun *et al*. (1982). Increasing of service period with age of mare may be associated with degenerative endometrial changes, incidence of acute endometrial and abnormal oocyte. Decreases in service period in mares older than 17, may result from keeping old mares with good fertility in the herd.

Average number of oestrus cycle and service number per gestation were nearly found the higher than previous studies (Kucuk, 1990; Koc and Altinel, 1992;

Table 4: Ratios of oestrus pregnency, sterility, parturition and abortion of Arabian mares for breeding years

		Oestrus		Pregnancy		Sterility		Parturition		Abortion and embryonic deaths	
Years	Mares at mating	n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
1976	94	91	96.81	17	18.09	77	81.91	17	18.09	0	0
1977	98	98	100.00	54	55.1	44	44.9	54	55.10	0	0
1978	75	75	100.00	53	70.67	22	29.33	51	68.00	2	2.67
1979	93	91	97.85	68	73.12	25	26.88	66	70.97	2	2.15
1980	93	91	97.85	42	45.16	51	54.84	40	43.01	2	2.15
1981	89	88	98.88	45	50.56	44	49.44	42	47.19	3	3.37
1982	92	92	100.00	74	80.43	18	19.57	72	78.26	2	2.17
1983	101	99	98.02	49	48.51	52	51.49	48	47.52	1	0.99
1984	103	101	98.06	44	42.72	59	57.28	42	40.78	2	1.94
1985	95	95	100.00	56	58.95	39	41.05	52	54.74	4	4.21
1986	86	86	100.00	59	68.60	27	31.40	57	66.28	2	2.33
1987	88	86	97.73	56	63.64	32	36.36	49	55.68	7	7.95
1988	92	92	100.00	80	86.96	12	13.04	78	84.78	2	2.17
1989	108	105	97.22	87	80.56	21	19.44	84	77.78	3	2.78
1990	110	108	98.18	88	80.00	22	20.00	83	75.45	5	4.55
1991	106	105	99.06	86	81.13	20	18.87	80	75.47	6	5.66
1992	139	139	100.00	95	68.35	44	31.65	89	64.03	6	4.32
1993	109	108	99.08	96	88.07	13	11.93	87	79.82	9	8.26
1994	107	106	99.07	87	81.31	20	18.69	77	71.96	10	9.35
1995	97	97	100.00	74	76.29	23	23.71	67	69.07	7	7.22
1996	107	104	97.20	90	84.11	17	15.89	81	75.70	9	8.41
1997	113	113	100.00	88	77.88	25	22.12	77	68.14	11	9.73
1998	107	103	96.26	88	82.24	19	17.76	83	77.57	5	4.67
1999	106	104	98.11	77	72.64	29	27.36	71	66.98	6	5.66
2000	105	104	99.05	92	87.62	13	12.38	89	84.76	3	2.86
2001	111	111	100.00	101	90.99	10	9.01	92	82.88	9	8.11
2002	111	109	98.20	102	91.89	9	8.11	96	86.49	6	5.41
2003	127	123	96.85	116	91.34	11	8.66	105	82.68	11	8.66
2004	118	118	100.00	110	93.22	8	6.78	100	84.75	10	8.47
2005	121	120	99.17	112	92.56	9	7.44	105	86.78	7	5.79
2006	122	119	97.54	99	81.15	23	18.85	92	75.41	7	5.74
Total	3223	3181	98.70	2385	74.00	838	26.00	2226	69.07	159	4.93

Ozdemir, 1998). It can be said that artifical and natural insemination were not done in appropriate time and way. In this farm, oestrus detection and artificial insemination should be performed at the right time and in an appropriate way. An appropriate teasing technique should practise in deciding whether mares are properly in heat. Control of ovulation and gestation examination between days 15 and 35 after ovulation by using ultrasonography in particularly should be given much attention. If the fact that mares are not pregnant has been diagnosed early enough in the season, it may be possible with a subsequent covering to have her conceive, thus avoiding the loss of a full breeding year.

According to breeding year, oestrus, pregnancy, sterility, parturition and abortion (also including embryonic death rates) are presented in Table 4. Before 2000 year, ratios of parturition and pregnancy were low. As ratio of parturition was higher than 80% after 2000 year, it can be concluded that reproductive performance of Arabian horses are higher at last years.

According to breeding age, oestrus, pregnancy, sterility, parturition and abortion rates are presented in Table 5. On the basis of mares at mating oestrus, from fertility records of 3223 mares, ratios of oestrus, sub oestrus, pregnancy, sterility, parturition and abortion were 98.70, 1.30, 74.00, 26.00, 69.07 and 4.93% for Arabian mares, respectively. Ratios of parturition and pregnancy in 17 years and older mares were lower than younger mares.

Ratios of parturition (foaling) and pregnancy (conception) for Arabian mares were, respectively 74.00 and 69.07%, which is at over limit of literature (Koc and Altinel, 1992; Yurdaydin and Sevinc, 1983; Kucuk and Altinel, 1992, Ozdemir, 1998; Schulman *et al*., 2003). It was done successfully Arabian horse breeding in this farm. Parturition and pregnancy ratios in 17 years of age and older were lower than young mares. Lower parturition and pregnancy ratios with increasing mare age may be associated with degenerative endometrial changes, incidence of acute endometrial and abnormal oocyte.

Parturition and pregnancy ratios after 2000 year were higher than other years. In this farm after 2000 year, it can be said that artificial and natural insemination were done in appropriate time and way and control of ovulation and gestation examination by using ultrasonography were done.

In this study, ratios of abortion and embryonic deaths were 4.93%, which is similar to other studies (Bruck *et al*., 1993; Hemberg *et al*., 2004). Most of foals were aborted before reaching 5 months of age

Table 5: Ratios of oestrus, pregnancy, sterility, parturition and abortion of Arabian mares for breeding age

Breeding Age	Mares at mating	Oestrus		Pregnancy		Sterility		Parturition		Abortion and embryonic deaths	
		n	(%)	n	(%)	n	(%)	n	(%)	n	(%)
4	327	318	97.25	240	73.39	87	26.61	222	67.89	18	5.50
5	304	302	99.34	241	79.28	63	20.72	233	76.64	8	2.63
6	294	291	98.98	243	82.65	51	17.35	222	75.51	21	7.14
7	284	281	98.94	210	73.94	74	26.06	202	71.13	8	2.82
8	278	274	98.56	213	76.62	65	23.38	198	71.22	15	5.40
9	255	255	100.00	187	73.33	68	26.67	173	67.84	14	5.49
10	232	230	99.14	168	72.41	64	27.59	159	68.53	9	3.88
11	212	211	99.53	151	71.23	61	28.77	146	68.87	5	2.36
12	193	190	98.45	141	73.06	52	26.94	128	66.32	13	6.74
13	160	159	99.38	122	76.25	38	23.75	114	71.25	8	5.00
14	146	145	99.32	108	73.97	38	26.03	99	67.81	9	6.16
15	120	118	98.33	86	71.67	34	28.33	77	64.17	9	7.50
16	100	98	98.00	74	74.00	26	26.00	69	69.00	5	5.00
17	78	77	98.72	52	66.67	26	33.33	51	65.38	1	1.28
18>	240	232	96.67	149	62.08	91	37.92	133	55.42	16	6.67
Total	3223	3181	98.70	2385	74.00	838	26.00	2226	69.07	159	4.93

(Klemetsal and Johnson, 1989; Tischner, 2002). Abortion can be caused by luteal insufficience, embryonic defects, endometritis, twinning, equine viral rhinopneumonitis etc. Luteal insufficience is one of the important causes of embryonic deaths. Yang and Cho (2007) reported high early embryonic death rate of 12.2% within 45 days after ovulation. Carioglu (1999) informed that in prevention of luteal insufficient, 100 mg of medroxyprogesterone acetate applications at intervals of 4 days could be recommended. These applications keep the serum progesterone level high during days 16-48, which are the most critical days of pregnancy.

CONCLUSION

The results of this study have shown that the under the conditions of Anadolu State farm purebred Arabian horses perform well in respect of productive traits after 2000 year. It can be said that Arabian horse breeding in this farm was done successfully. However; in this farm, more profitable horse breeding depends on mare's having a live foal in the every year. To avoid the loss of a full breeding year and have much chance for gestation, mares should be mated in earlier month in breeding season. Artificial photoperiod, simulating long days, can be used to advance the time of the first ovulation of the year in mares in this farm Proportions of sterility, abortion and embryonic death should be decreased. These ratios can be reduced with better management and culling of barren mares, old mares and mares with Emphysema Pulmonum. Oestrus detection and artificial insemination should be performed at the right time and in an appropriate way. An appropriate teasing technique should practice in deciding whether mares are properly in heat. Controls of ovulation and gestation examination by using ultrasonography should be done.

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