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Age related effect on pregnancy rate and pregnancy wastage in thoroughbred mares bred during different heat cycles postpartum under subtropical conditions

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ABSTRACT

This investigation reports the correlation of age and heat cycles on the pregnancy rate and pregnancy wastage in Thoroughbred mares bred during foal heat (FH), second heat (SH) and third heat (TH) in a commercial stud farm in Kunigal, Karnataka, India. The pregnancy rate was not influenced by the different heat cycles post partum. The correlation of mare's age on the pregnancy rate and heat cycles showed that the age of the mares significantly influenced the conception rate in mares bred during FH and TH postpartum, while it was not significant in SH. The mare's age did not influence the pregnancy wastage significantly in mares bred during FH, SH or TH, but the FH bred mares showed significantly higher early embryonic mortality rate than SH and TH bred mares. While the abortion rate was not influenced by the different heat cycles postpartum. In conclusion, the reproductive efficiency with respect to pregnancy rate was age dependent, while pregnancy wastage looked independent of age in Thoroughbred mares bred on FH, SH and TH. The optimum age for better pregnancy rate was between 6 and 13 years in all the heat cycles and aged mares (>18 years old) showed reduced pregnancy rate due to increased pregnancy losses.

Keywords: Age, Heat cycles, Pregnancy rate, Pregnancy wastage, Thoroughbred mares

One of the primary requirements for efficient and economically viable broodmare management is the production of a foal per year. The limitations of a long gestation period (mean of 335 to 345 days) and a limited physiological breeding season (February to June under Indian subtropical conditions) leaves little margin for error and gradual drift (13±23 days) in consecutive foaling dates results in failure to produce a yearly foal after an average of only 3.4 yr of breeding (Bosh *et al*. 2009). The time from parturition to the resumption of cyclic ovarian activity is very short in mares and the first fertile estrus occurs as early as 6 to 20 days after foaling, this necessitates breeding mares during the first postpartum oestrus, commonly referred to as foal heat (Ginther 1992). Hence exploiting the foal heat would be beneficial and economical to the equine industry.

Pregnancy rates from mares bred on foal-heat have been reported to be lower than in mares bred on subsequent post partum estrus periods and the difference in pregnancy rate in per cent was 72 v/s 82 (Camillo *et al.* 1997), 57.1 v/s 82.3 (Carluccio *et al*. 2016) and 39.28 v/s 60.71 (Akourki *et al*. 2017). In contrast, Bruemmer *et al*. (2002) and Blanchard *et al*. (2004) have dis-approved the difference in pregnancy rates between foal heat bred mares and breeding on subsequent heat cycles. The embryonic mortality rate in per cent was 30.3 v/s 11.5 (Kurtz Filho *et al*. 1999) and 10.4 v/s 8.0 (De-Souza *et al*. 2020) in mares bred during foal heat and subsequent cycles postpartum. As reported by quite a few authors, it is well evident that the reproductive performance of the mares deteriorates as the age advances (Sharma *et al*. 2010, Blanchard *et al*. 2012, Warriach *et al*. 2014, Lane *et al*. 2016 and De-Souza *et al*. 2020).

Therefore this investigation was carried out to evaluate the effect of mare's age and different heat cycles post partum (FH, SH and TH) on pregnancy rate and pregnancy wastage rate in thoroughbred mares.

MATERIALS AND METHODS

The present study was conducted in a Thoroughbred stud farm situated in the southern part of India located at latitude 13.0232 N and longitude 77.0252 E with an average altitude of 2536 feet in a total of 98 mares (519 mare years**,** since the majority of mares remained on the same stud farm for several years and were bred each year, many mares appear in the data for more than one year, therefore for ''mare'' read ''mare years'') for retrospective studies. The mares were kept in an open shelter and outdoor paddock, fed daily ration according to their reproductive status, as practiced in Indian stud farms (Lucerne/hay and pasture grass *ad lib.* plus 6 kg of concentrate divided thrice a day).

Reproductive records were analysed for mares (519 mare years) aged between 6 and 23 years, recorded over seven years (2008–2015, excluding data from 2009 as it was not available on the farm). A survey form was prepared

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and data pertaining to reproductive status of the mares were recorded from yellow sheets present in the stud farm. (The pregnancy was confirmed by ultrasonography on day 14 post covering. The next confirmation was done at 18th day, 21st day and 28th day post covering. Likewise, the developing fetus was scanned on a regular basis to check for optimum growth and viability). The resorption, abortion and birth of still born, if any were recorded throughout the gestation period. The data obtained were analysed statistically by SPSS.V.16 software (SPSS Inc, Chicago, Illinois, USA). Chi-squared tests was used to compare percentage values using SPSS v17 with the significance level set at $p<0.05$.

RESULTS AND DISCUSSION

Influence of different types of heat (foal heat, second heat and third heat) on pregnancy rate in mares: The influence of different types of heat cycles on the pregnancy rate in mares was analysed using chi square analysis (Table 1). The pregnancy rate was statistically similar in mares bred during FH, SH and TH postpartum.

Table 1. Influence of different types of heat (foal heat, second heat and third heat) on pregnancy rate in mares

Age group	Overall		
	N	Positive	%
Foal heat	85	52	61.18
Second heat	313	201	64.21
Third heat	108	70	64.81
$\chi 2$ value		0.2161 NS	

N: Number of mares; NS: Non-significant.

The overall pregnancy rate following breeding at the foal heat was 61.18% in the present study which is similar to 60.2% as reported by Ishii *et al*. (2001). McCue and Hughes (1990) and Bruemmer *et al*. (2002) have recorded 68.4% and 81.0% pregnancy rate, respectively in mares bred in foal heat which is higher than the present work, while the conception rate of the mare covered at foal heat was 57.6% (Morris and Allen 2002), 57.96% (Sharma *et al*. 2010), 46.6% (Aoki *et al*. 2013), 39.28% (Akourki *et al*. 2017) and 20% (Mahal *et al*. 2020) which are much lower than the pregnancy rate reported in the present study.

No significant difference was apparent in the reproductive performance of foal heat bred mares when compared to those bred during SH and TH postpartum in the current study. This, again, is in agreement with several previous studies in thoroughbred mares (Malschitzky *et al*. 2001 and Sharma *et al*. 2010). This non-significant differences in pregnancy rate in mares could be due to faster uterine involution, presence of lesser intra uterine fluid and inflammatory byproducts in the uteri which again can be attributed to more number of eutocias, healthy parturition premises, reduced mean placental retention time, delayed ovulation postpartum and number of days post-partum at the time of covering (Ishii *et al*. 2001, Warriach *et al*. 2014, Lane *et al*. 2016, Carluccio *et al*. 2016 and Mahal *et al*. 2020).

Influence of age on pregnancy rates in mares bred during foal heat, second heat and third heat postpartum: The chi square analysis (Table 2) revealed that the age of the mares had significant influence on the pregnancy rate in mares bred during foal heat (p=0.025) and third heat (p=0.042), while the pregnancy rate in mares bred during the second heat was not significantly affected by age. There is clear evidence that mare's age has a profound effect on the reproductive performance in mares. All studies have common conclusion that the advancing age has a negative effect on the reproductive performance (Morris and Allen 2002, Malschitzky *et al*. 2003, Blanchard *et al*. 2004, Sharma *et al*. 2010 and Lane *et al*. 2016). Although there is a linear reduction in fertility with aging, the problem seems to be aggravated from the age of 18 years on, which can be attributed to progressive uterine degenerative injuries.

Several contributing factors for lower pregnancy rates in aged mares are anatomical abnormalities in vulva - progressive cranial collapse of dorsal labia commissure (McKinnon *et al*. 2011), increased susceptibility to uterus inflammation, persistent post breeding endometritis which can lead to pathological fluid accumulation in the uterus, early embryonic mortality, progressive uterine fibrosis, endometrial cyst formation (Wilsher and Allen 2003, Morel *et al*. 2005) and ovulatory disturbances (McCue and Squires 2002). Hence, it can be concluded that the older mares had significantly poorer pregnancy rates when compared to their younger and middle aged counterparts and significantly half of the mares bred were found to be negative for pregnancy in mares aged beyond 18 years in the present study.

Influence of age on pregnancy wastage in mares bred during different types of estruses (foal heat, second heat and third heat): In the present study, chi square analysis on the influence of age of mares on the pregnancy wastage in mares bred during FH, SH and TH (Table 3) showed that the age did not influence the pregnancy wastage significantly.

Pregnancy losses in mares are in increasing trend with

Table 2. Influence of age on pregnancy rate in mares bred during different estrus (foal heat, second heat and third heat)

Age group	Foal heat			Second heat			Third heat			Overall		
	N	Positive	%	N	Positive	%	N	Positive	%	N	Positive	%
6-12 yrs	26	21	80.77	92	62	67.39	31	25	80.65	149	108	72.48
13-17 yrs	36	21	58.33	147	96	65.31	56	36	64.29	239	153	64.02
18-23 yrs	23	10	43.48	73	43	58.90	21	9	42.86	117	62	52.99
$\chi 2$ value	7.358* (p=0.0252)			2.057 NS			8.169* (p=0.0426)			11.37** (p=0.0099)		

N: Number of mares; * & ** indicates the significant difference at p<0.05 and p<0.01; NS: Non-significant.

Table 3. Influence of age on pregnancy wastage (PW) in mares bred during different estrus (FH, SH and TH)

Age group	Foal heat			Second heat			Third heat			Overall		
	N	PW	%	N	PW	%	N	PW	%	N	PW	%
6-12 yrs	21	4	19.05	62	11	17.74	25	5	20.00	108	20	18.52
13-17 yrs	21	6	28.57	96	18	18.75	36	5	13.89	153	29	18.95
18-23 yrs	10	4	40.00	43	10	23.26	9	0	0.00	62	14	22.58
$\chi 2$ value		1.56 ^{NS}			1.832 ^{NS}			3.97 ^{NS}			2.797 ^{NS}	

N: Number of mares positive for pregnancy; NS: Non-significant

Table 4. Influence of foal heat, second heat and third heat postpartum on different catagories of pregnancy wastage in mares.

Heat cycle	N	EDD		Abortions		Still births		Overall pregnancy wastage	
		Yes	%	Yes	%	Yes	%	Yes	%
FH	52	11	21.15	3	5.77	0	0.00	14	26.92
SH	206	16	7.77	24	11.65	1	0.49	40	19.41
TH	71	6	8.45	5	7.04	0	0.00	11	15.49
$\chi 2$ value		8.495*(p=0.0143)		2.379 ^{NS}		0.5989 ^{NS}		2.454 ^{NS}	

* indicates the significant difference at $p<0.05$

increase in mare's age although not significant in the present observation are in line with Sharma *et al*. (2010), Blanchard *et al*. (2012) and Lane *et al*. (2016). Several contributory factors for pregnancy wastage in relation to mare's age have been summerized and they are chromosomally abnormal oocytes (Rambags *et al*. 2005), anatomical abnormalities in vulva (Wilsher and Allen 2003, McKinnon *et al*. 2011), age related luteal insufficiency leading to decreased maternal progesterone (Hendriks *et al*. 2009); progressive degeneration of the uterine tissue, endometrial fibrosis, inflammatory cell infiltration, endometrial cyst development and uterine gland atrophy (Pycock 2006).

Influence of foal heat, second heat and third heat post partum on different catagories of pregnancy wastage in mares: In the present study, chi square analysis showed significant influence of FH, SH and TH on early embryonic death in mares, while significant influence was not observed on abortion and still birth rate (Table 4). Our findings of higher incidence of early embryonic death in mares bred during FH when compared to SH and TH is in accordance with Bell and Bristol (1987) (26% v/s 16%) and Kurtz Filho *et al*. (1999) (30.3% v/s 11.5%) for foal heat and subsequent estrus mares, respectively.

Embryonic losses in FH bred mares in the present study was 21.15% which is lesser when compared to 26% (Bell and Bristol 1987), 30.3% (Kurtz Filho *et al*. 1999) and 30.5% (Malschitzky *et al*. 2003). The difference in the early embryonic death rate in the present study in mares bred during foal heat with other findings could be due to early uterine involution, presence of smaller quantity of intra uterine fluids with few inflammatory cells at the time of breeding. In contrast, 10.0% (Lowis and Hayland 1999), 17% (Morris and Allen 2002), 8.80% (Sharma *et al*. 2010) and 6.4% (Barber *et al*. 2012) of mares showed early embryonic mortality.

The abortion rates ranged from 5-12% for in the present study is found to be in line with 9.3% (Lowis and Hayland 1991) and 4.74 % (Barber *et al*. 2012). Abortions have been reported due to multifactorial etiology including hormonal, genetic, infectious (Ravi *et al*. 2013, Weber *et al*. 2018) and non infectious - twin pregnancies, fetal malformations, umbilical cord strangulations, long cord/cervical pole ischaemia disorder and uterine torsion (Smith *et al*. 2003, Weber *et al*. 2018). The contributory factors for abortion in present study could be infectious and non-infectious, where the causes for the same have not been evaluated in the present work.

The assumption that the fertility of FH bred mares is inferior to that of SH and TH bred mares is proved to be wrong in the present study but, the hypothesis of pregnancy rate in FH bred mares is age-dependent is confirmed. The results obtained in the present study indicate that older mares should be bred on SH as a breeding strategy to increase the pregnancy rate and optimize the reproductive efficiency in mares. The concept of increased early embryonic death rate in mares bred during foal heat is yet again proved in the present work, while the pregnancy wastage is found to be unaffected in mares bred during different heat cycles postpartum. The present study also proved that the reproductive efficiency decreases in mares which are aged beyond 18 years and such data can be exploited to minimise the economical loss incurred to the equine industry.

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