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Impact of seasonal variation on foal estrus breeding success in mares in Iraq

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This study aimed to evaluate the influence of seasonal variations on foal estrus breeding success in mares in Iraq by analyzing pregnancy rates and preovulatory follicular diameters across four distinct seasons over a calendar year. The investigation was conducted at the Veterinary Clinic of the College of Veterinary Medicine, University of Diyala, Iraq, and involved forty-seven lactating mares aged between 5 and 14 years. Follicular dynamics, cyclicity patterns, and preovulatory follicle sizes were monitored via transrectal palpation followed by ultrasonographic examinations using a portable ultrasound scanner equipped with a 5.0–8.5 MHz multi-frequency linear transducer, performed by a single operator from day 7 until day 13 postpartum. All mares were naturally bred during the foal heat on days 9, 11, and 13 postpartum, and pregnancy diagnosis was confirmed between days 15 and 40 after the final breeding session via the visualization of the embryonic vesicle or early embryo. The results demonstrated that the mean preovulatory follicular diameters peaked significantly during autumn (37.9±2.17 mm) and summer (37.6±2.06 mm) compared to winter (34.1±1.59 mm) and spring (33.6±1.84 mm) ($P \leq 0.05$), with the least significant difference value established at 3.081. Concurrently, seasonal shifts exerted a highly significant effect on breeding outcomes ($P=0.0087$), yielding an overall pregnancy rate of 57.45 %. The highest pregnancy success was recorded during summer (66.67 %) and spring (65.00 %), followed by autumn (50.00 %), whereas the winter season exhibited a severe reproductive decline, characterized by the lowest pregnancy rate (37.50 %) and a corresponding peak in non-pregnancy outcomes (62.50 %). The study concludes that regional seasonal climatic conditions act as primary drivers of equine fertility, heavily favoring warmer and photo-stimulated periods. These findings underscore the necessity of integrating strategic seasonal planning and management into local equine breeding programs to optimize reproductive performance and minimize the economic losses associated with failed breeding attempts in unfavorable seasons.

Keywords: mares, seasonal variations, pregnancy rate, follicular diameter, ultrasonography, Iraq.

Вплив сезонних коливань на успішність запліднення кобил у період першої післяродової охоти в Іраку

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Це дослідження мало на меті оцінити вплив сезонних коливань на успішність розведення кобил у період післяродової охоти в Іраку шляхом аналізу показників вагітності та діаметра преовуляторних фолікулів у різні сезони року. Дослідження проводили на базі ветеринарної клініки факультету ветеринарної медицини Університету Діяла, Ірак. Дослідну вибірку склали 47 лактуючих кобил віком від 5 до 14 років. Динаміку фолікулів, особливості циклічності та розміри преовуляторних фолікулів контролювали за допомогою ректальної пальпації з наступним ультразвуковим дослідженням портативним ультразвуковим апаратом, оснащеним багаточастотним лінійним датчиком із частотою 5,0–8,5 МГц. Дослідження виконував один оператор із 7-го по 13-й день післяродового періоду. Усі кобили були осіменені природним шляхом під час першої післяродової охоти на 9-й, 11-й та 13-й день після вижеребления, а діагностику вагітності підтверджували в період між 15-м і 40-м днями після останнього осіменіння шляхом візуалізації ембріона на ранніх стадіях розвитку. Результати продемонстрували, що середні діаметри преовуляторних фолікулів досягали свого піку восени (37,9±2,17 мм) та влітку (37,6±2,06 мм), що було суттєво більше порівняно із зимою (34,1±1,59 мм) та весною (33,6±1,84мм) ($P \leq 0,05$), при цьому значення найменшої істотної різниці становило 3,081. Водночас сезонні зміни виявили високозначущий вплив на результати розведення ($P=0,0087$), забезпечивши загальний показник вагітності на рівні 57,45 %. Найвищу запліднювальну ефективність кобил зафіксовано влітку (66,67 %) та навесні (65,00 %), далі восени (50,00%), тоді як взимку спостерігалося різке зниження репродуктивної функції, що характеризувалося найнижчим показником вагітності (37,50 %). Взимку зафіксовано найбільшу кількість незапліднених кобил (62,50 %). Отримані результати свідчать, що регіональні сезонні кліматичні умови є ключовими чинниками, які впливають на репродуктивну функцію кобил, із вираженою інтенсифікацією фізіологічних процесів у теплі періоди з подовженим світловим днем. Отримані результати підкреслюють необхідність інтеграції стратегічного сезонного планування та менеджменту в місцеві програми розведення коней з метою оптимізації репродуктивних показників і мінімізації економічних збитків, пов'язаних із невдалими спробами запліднення у менш сприятливі сезони.

Ключові слова: кобили, сезонні коливання, вагітність, діаметр фолікула, ультрасонографія, Ірак.

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Introduction

The reproductive efficiency of mares plays a crucial role in the success of equine breeding programs. Estrus, ovulation, and conception rates are influenced by a range of intrinsic and extrinsic factors, among which seasonal variation is one of the most impactful. Understanding how changes in photoperiod, temperature, and humidity across the seasons affect reproductive behavior and physiology in mares is essential for optimizing breeding management, especially in regions with distinct climatic shifts such as Iraq [1].

In seasonal breeders like horses, reproductive activity is closely aligned with environmental stimuli. Changes in daylength and temperature regulate the hypothalamic-pituitary-gonadal (HPG) axis, which in turn modulates estrous cyclicity and ovulatory patterns. Studies across various breeds and climates have demonstrated significant variations in gestational length, ovulation timing, and pregnancy success across seasons [2, 3]. These physiological responses are particularly relevant in countries characterized by extreme weather differences between summer and winter.

Mares generally exhibit increased reproductive activity during spring and early summer due to longer daylight hours, which stimulate follicular development and ovulation. Conversely, during the shorter daylight periods of late autumn and winter, mares may enter a transitional or anovulatory state, leading to reduced or absent estrous cycles [4, 5]. This seasonal reproductive suppression has been documented in both natural and controlled breeding environments.

Similar observations have been made in horses bred in southern climates, where spring and summer yield more consistent pregnancy rates than winter or autumn [3, 6]. These findings underscore the necessity of synchronizing breeding programs with favorable environmental windows.

In subtropical climates, such as India, researchers have observed that postpartum estrus and early ovarian activity are more pronounced during warmer months, contributing to higher foal-heat conception rates [7, 8]. Iraq's geographical and climatic conditions share distinct similarities with such subtropical regions, raising critical questions about how seasonal variations impact local mare fertility rates. Seasonal shifts influence not only reproductive hormones and follicular dynamics but also exert broader physiological and behavioral effects. This highlights the multifactorial nature of seasonal breeding performance.

Following parturition, the first postpartum estrus, commonly known as the foal heat or foal estrus, occurs approximately 7 to 14 days after foaling and is frequently exploited by breeders for early rebreeding. However, conception rates achieved during this period can fluctuate significantly depending on the season [6, 9].

In Central and Eastern Europe, research conducted by [10] emphasized how fluctuating environmental conditions across seasons alter ovulation intervals, estrus duration, and pregnancy rates. These data reinforce the necessity of region-specific reproductive studies, as environmental influences can differ even within similar latitudes due to local ecological factors. Iraq, with its arid summers and cold winters, remains underrepresented in this body of literature.

In conclusion, the synchronization between environmental aspects and reproductive behavior in mares is well-established in the global literature [11–14]. However, regional studies remain indispensable due to geographic specificity. The findings of this research will contribute significantly to the body of knowledge on equine reproduction in the Middle East and will serve as a practical guide for enhancing breeding success through seasonally informed management strategies.

Given the lack of comprehensive data from Iraq, there is a critical need to understand how distinct regional climatic factors influence equine reproduction in this area. Investigating these patterns across spring, summer, autumn, and winter is essential for establishing region-specific management frameworks and improving local mare fertility rates.

The aim of the study

The aim of this study was to evaluate the impact of seasonal variations on estrous behavior, follicular diameter, and pregnancy success in mares, thereby identifying the optimal breeding windows and providing actionable, science-based recommendations for Iraqi horse breeders.

Materials and methods

Animals

The present study was conducted at the Veterinary Clinic of the College of Veterinary Medicine, University of Diyala, Diyala, Iraq, and involved forty-seven lactating mares aged between 5 and 14 years, according to owner records. The investigation spanned four consecutive seasons over a one-year period. Mares that had lost their foals within the first week postpartum were also included in the study cohort. All forty-seven mares were bred during the foal estrus on days 9, 11, and 13 postpartum. Throughout the study, the animals were continuously maintained on a standardized diet consisting of grain-based concentrate and green fodder.

Ultrasonographic examinations

At each postpartum scanning session, transrectal palpation was performed first, followed by transrectal ultrasonographic (US) examination from day 7 until day 13 postpartum. These examinations were conducted to monitor follicular development, determine preovulatory follicle diameter, and ultrasonographically assess the presence of endometrial folds and uterine mucus. Pregnancy diagnosis was performed between days 15 and 40 after the last breeding session via the visualization of the embryonic vesicle or the early embryo [9]. All ultrasonographic evaluations were performed by a single operator using a portable V10 ultrasound scanner (China) equipped with a 5.0–8.5 MHz multi-frequency linear transducer, following the established protocol described by [15]. Mares with

ovarian follicles measuring less than 25 mm in diameter were classified as anestrus (acyclic), whereas mares presenting with follicles between 25 and 30 mm were considered cyclic [14].

Statistical analysis

Data were analyzed using the Statistical Analysis System (SAS, version 9.4) software program to evaluate the effects of seasonal variations on follicular diameter and pregnancy outcomes (pregnant vs. non-pregnant mares). One-way analysis of variance (ANOVA) was performed, and the Least Significant Difference (LSD) test was utilized to compare differences between mean values. Statistical significance was set at P≤0.05.

Results and discussion

The influence of seasonal variations on reproductive parameters in mares demonstrated distinct patterns across the four studied seasons.

Analysis of follicular development during the foal estrus revealed that the mean follicular diameter peaked during autumn (37.9±2.17 mm) and summer (37.6±2.06 mm). These values were significantly greater (P≤0.05) compared to the smaller diameters recorded during spring (33.6±1.84 mm) and winter (34.1±1.59 mm), with the Least Significant Difference (LSD) value established at 3.081 (***Fig. 1***).

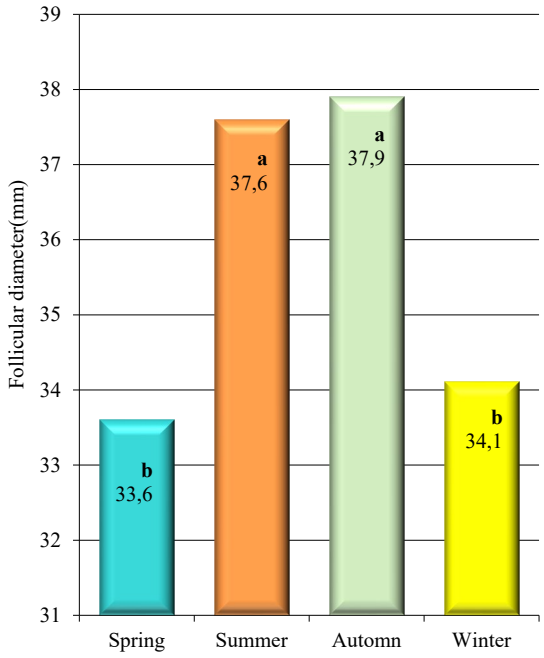

Fig. 1. Mean follicular diameter (mm) of mares during foal estrus across different seasons.

Note: Columns marked with different letters (a, b) differ significantly (P≤0.05) based on the Least Significant Difference (LSD) test.

Concurrently, seasonal shifts exerted a highly significant effect on breeding outcomes (P=0.0087), with warmer seasons yielding enhanced reproductive efficiency (***Table 1***).

Table 1.

Effect of seasonal variations on pregnancy and non-pregnancy rates in mares bred during foal estrus

Season	No. of breedings	Pregnant (%)	Non-pregnant (%)
Spring	20	13/20 (65.00)	7/20 (35.00)
Summer	9	6/9 (66.67)	3/9 (33.33)
Autumn	10	5/10 (50.00)	5/10 (50.00)
Winter	8	3/8 (37.50)	5/8 (62.50)
Total	47	27/47 (57.45)	20/47 (42.55)
Statistical	---	P = 0.0087	

Note: Statistical significance was determined at P≤0.05.

The highest pregnancy rates were achieved during summer (66.67 %) and spring (65.00 %), whereas the winter season was characterized by the lowest conception success (37.50 %) and a corresponding peak in non-pregnancy rates (62.50 %). The overall pregnancy rate across the entire study population stood at 57.45 %, underscoring the suppressive impact of colder winter conditions on equine fertility.

Taken together, these results demonstrate a clear synchronicity between ovarian dynamics and overall breeding efficiency in mares. The significant increase in preovulatory follicular diameter during the warmer and transitional light periods (summer and autumn) correlates with higher conception success. Conversely, the reduction in follicular size during winter corresponds with a pronounced decline in pregnancy rates. This statistical alignment confirms that seasonal climatic factors are primary drivers of reproductive performance in this geographic region, establishing a baseline for comparative analysis.

Seasonal variation plays a pivotal role in determining reproductive outcomes in mares, as evidenced by the current findings from Iraq. The data revealed distinct differences in follicular diameter and pregnancy success across the four seasons during the foal estrus, with warmer seasons demonstrating improved reproductive metrics. This pattern underscores the biological sensitivity of equine reproductive physiology to environmental conditions, particularly temperature and photoperiod [10]. In the current study, a statistically significant difference in pregnancy rates was observed across seasons (P<0.01). The overall pregnancy rate for mares bred during the foal heat was 57.45 %, which closely aligns with the 57.90 % and 56.80 % reported in previous literature [7, 16].

In contrast, significantly higher pregnancy rates of 81.00 % have been recorded in mares bred during the foal heat under different conditions [17]. These discrepancies might be attributable to the relatively low number of mares in our study, as well as variations in reproductive management practices [18]. In this context, higher pregnancy rates in previous reports may also be explained by the application of artificial breeding techniques compared to the natural breeding methods employed in the present study. Artificial management can substantially reduce intrauterine fluid accumulation in postpartum mares, thereby enhancing fertility outcomes [19].

Conversely, some literature has reported substantially lower foal heat conception rates of 46.60 % [9, 20], 39.28 % [21], and 20.00 % [22] compared to the findings

of the present study. The superior pregnancy rates observed in our results compared to these lower historical data could be ascribed to minimal intrauterine fluid retention, a low concentration of inflammatory cells, and rapid, early uterine involution. Nonetheless, it is worth noting that some researchers have documented lower conception rates accompanied by high embryonic mortality in mares bred at the foal heat, even in the absence of obvious pathological conditions [23–25].

In the current study, it was observed that follicular development and pregnancy rates were notably enhanced during summer and spring, while winter proved less favorable. These findings align with multiple studies indicating that photoperiod and temperature shifts modulate hormonal cycles and fertility outcomes in equines [26, 27].

Interestingly, despite similar follicular diameters observed in summer and autumn, the pregnancy success differed markedly between these two seasons. Summer achieved the highest pregnancy rate at 66.67 %, while autumn recorded only 50.00 %. This discrepancy suggests that while follicular size is important, it is not the sole determinant of conception success. Other factors, such as uterine receptivity, oocyte quality, and environmental stressors, may significantly contribute to the variability in outcomes [14, 24]. Concurrently, literature suggests that autumn represents a transitional phase where reproductive efficiency begins to decline [10]. This period may reflect the early onset of photoperiod-induced regression, characterized by a subtle reproductive decline beginning in late autumn.

In spring, the mean follicular diameter was significantly smaller (33.6±1.84 mm) than in summer and autumn, yet the pregnancy rate remained relatively high (65.00 %). This indicates that while spring follicles may be smaller, they are still fully capable of producing viable oocytes and supporting successful conception. Such a pattern is consistent with prior research, which documented favorable reproductive outcomes during the spring in subtropical climates despite moderate follicular measurements [23].

Conversely, winter presented the most unfavorable conditions for reproduction, exhibiting both a smaller average follicular diameter (34.1±1.59 mm) and the lowest pregnancy rate (37.50 %). Statistical testing confirmed the significance of this seasonal suppression. Previous physiological models explain that during winter, mares experience reduced estrous behavior, diminished luteinizing hormone surges, and increased melatonin levels, which collectively contribute to decreased fertility [11].

Interestingly, while the present results strongly support the impact of seasonal variations, they also point to individual mare factors that may modulate reproductive outcomes. For instance, certain mares achieved successful pregnancy despite presenting with smaller preovulatory follicles, comparable to the sizes characteristically recorded during the winter and spring months. This observation aligns with prior findings, which documented significant individual variability in reproductive efficiency among animals maintained within the same herd and managed under identical environmental conditions [28].

Conclusions

This study demonstrates a significant seasonal influence on the preovulatory follicular dynamics and breeding efficiency of mares during the foal estrus in Iraq. The mean follicular diameter peaked during autumn (37.9±2.17 mm) and summer (37.6±2.06 mm), which was significantly larger ($P \leq 0.05$) than the measurements recorded in winter (34.1±1.59 mm) and spring (33.6±1.84 mm). Concurrently, seasonal shifts profoundly affected pregnancy outcomes ($P=0.0087$). Against an overall study pregnancy rate of 57.45%, the highest breeding success was achieved during summer (66.67 %) and spring (65.00 %), whereas the winter season exhibited a severe reproductive decline with the lowest pregnancy rate of 37.50 % and a corresponding peak in non-pregnancy outcomes (62.50 %). These quantified metrics confirm that despite the regional subtropical climate, local mares remain highly sensitive to environmental stimuli, establishing spring and summer as the statistically optimal windows for maximizing equine fertility.

Practical recommendations

Optimization of Foal Heat Utilization: To achieve the target reproductive efficiency of one foal per mare per year and maximize the reproductive potential of the herd, breeding programs should systematically utilize the foal estrus as a tool to enhance overall fertility.

Strategic Breeding Scheduling: Equine breeding schedules in Iraq should strictly prioritize the spring and summer months. This alignment maximizes conception efficiency and significantly reduces the economic burden associated with failed breeding attempts during less favorable seasons.

Directions for Future Research: Future investigations should incorporate endocrine profiling (specifically monitoring estradiol and progesterone levels) alongside ultrasonographic evaluations and breeding outcomes. This multi-parametric approach will provide a deeper, more mechanistic understanding of the observed seasonal differences in equine fertility.

DECLARATIONS

Ethical Statement

The authors declare that all experimental procedures and diagnostic manipulations in this study were conducted in strict accordance with the internationally accepted guidelines for the care and use of laboratory and agricultural animals, including Directive 2010/63/EU of the European Parliament and the Council of September 22, 2010, on the protection of animals used for scientific purposes. The clinical part of the research complied fully with the national regulations and ethical standards governing veterinary practices and animal welfare in Iraq. Prior to any ultrasonographic examinations or veterinary procedures, official written informed consent was obtained from all mare owners. Throughout the

investigation, the mares were provided with appropriate housing, standard balanced nutrition, quality veterinary care, and total minimization of stress, pain, or any discomfort.

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Conflict of Interest

The authors state that there is no conflict of interest.

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Declaration of AI and AI-assisted technologies

The authors declare that no generative AI or AI-assisted technologies were used during the preparation, writing, translation, or language polishing of this manuscript. The final content was fully authored and reviewed by the researchers, who take joint responsibility for the work.

References

1. Rasheed, Y. M., & Ghareeb, S. H. (2018). Impact of ultrasonographic monitoring in reproductive efficiency of mares during months of year in Iraq. *Diyala Agricultural Sciences Journal*, 10, 255–264. https://journal.djas.uodiyala.edu.iq/index.php/dasj/article/view/3548
2. Reilas, T., Virtala, A.-M., & Katila, T. (2014). Gestation lengths of Finnhorse and Standardbred mares in Finland: effects of breeding season and reproductive status. *Pferdeheilkunde*, 30(1), 45–51. https://doi.org/10.21836/pem20140107
3. Lazim, E. H., & Al-Watar, B. D. (2025). Ultrasonographic detection of fetal sexing in nanny goat. *Iraqi Journal of Veterinary Sciences*, 39(1), 1–7. https://doi.org/10.33899/ijvs.2024.153995.3915
4. King, S. S., Douglas, B. L., Roser, J. F., Silvia, W. J., & Jones, K. L. (2010). Differential luteolytic function between the physiological breeding season, autumn transition and persistent winter cyclicity in the mare. *Animal Reproduction Science*, 117(3-4), 232–240. https://doi.org/10.1016/j.anireprosci.2009.04.012
5. Rasheed, Y. M., Khalaf, F. H., & Mohammed, S. N. (2023). Assessment of fetal sex determined and eye diameter to detection of gestational age in mares by ultrasonography. *Iraqi Journal of Veterinary Sciences*, 37(Supplement I-IV), 129–134. https://doi.org/10.33899/ijvs.2023.1375080.2691
6. Blanchard, T. L., Thompson, J. A., Love, C. C., Brinsko, S. P., Ramsey, J., O'Meara, A., & Varner, D. D. (2012). Influence of day of postpartum breeding on pregnancy rate, pregnancy loss rate, and foaling rate in Thoroughbred mares. *Theriogenology*, 77(7), 1290–1296. https://doi.org/10.1016/j.theriogenology.2011.10.034
7. Sharma, S., Morel, M. C. G. D., & Dhaliwal, G. S. (2010). Factors affecting the incidence of postpartum oestrus, ovarian activity and reproductive performance in Thoroughbred mares bred at foal heat under Indian subtropical conditions. *Theriogenology*, 74(1), 90–99. https://doi.org/10.1016/j.theriogenology.2010.01.018
8. Ali, M. K., & Aliraqi, O. M. (2025). Ultrasound evaluation of colic in horses: Diagnosis and severity assessment. *Iraqi Journal of Veterinary Sciences*, 39(1), 43–51. https://doi.org/10.33899/ijvs.2024.152675.3825
9. Lazim, E. H., Aziz, D. M., & Rahawy, M. A. (2022). Transabdominal ultrasonographic determination of pregnancy and fetal viability in mares. *Iraqi Journal of Veterinary Sciences*, 36(3), 791–796. https://doi.org/10.33899/ijvs.2022.132142.2054
10. Vilhanová, Z., Novotný, F., Valocký, I., Hura, V., Horňáková, P., & Karamanová, M. (2021). Effect of seasonal environmental changes on selected reproductive parameters in mares. *Bulgarian Journal of Veterinary Medicine*, 24(2), 208–218. https://doi.org/10.15547/bjvm.2019-0083
11. Voigt, U. (2020). *Influence of weather parameters on the fertility of horse mares (Equus caballus)* [Doctoral dissertation, Justus-Liebig-Universität Gießen].
12. Spencer, K. M., Podico, G., Megahed, A. A., Jones, K. L., Bittar, J. H. J., & Canisso, I. F. (2022). Ovulatory response to GnRH agonist during early and late fall in mares. *Theriogenology*, 185, 140–148. https://doi.org/10.1016/j.theriogenology.2022.03.003
13. Cardona-García, M., Jiménez-Escobar, C., Ferrer, M. S., & Maldonado-Estrada, J. G. (2024). Follicular dynamics and pregnancy rates during foal heat in Colombian Paso Fino mares bred under permanent grazing. *Animals*, 14(5), 760. https://doi.org/10.3390/ani14050760
14. Mahmood, K., Hassan, M., Channa, A. A., Ghafoor, A., & Riaz, A. (2024). Comparative analysis of breeding patterns and reproductive efficiency of mares in subtropical conditions of Pakistan. *Veterinary Medicine and Science*, 10(5), e1582. https://doi.org/10.1002/vms3.1582
15. Omran, S. N., & Rasheed, Y. M. (2013). Optimal post -breeding interval for pregnancy diagnosis in mares by using ultrasonographic technique. *The Iraqi Journal of Veterinary Medicine*, 37(2), 206–210. https://doi.org/10.30539/iraqijvm.v37i2.293
16. Yendim, S. K., Aksen, O. U., Yıldırım, S., Uzabaci, E., Sarýoglu, S., Yıldız, G. E., Keskin, A., & Yilmazbas-Mecitoglu, G. (2025). The evaluation of fertility following foal heat or the subsequent postpartum estrus in purebred Arabian mares. *Indian Journal of Animal Research*, 59(8), 1303–1309. https://doi.org/10.18805/IJAR.BF-1929
17. Bruemmer, J. E., Brady, H. A., & Blanchard, T. L. (2002). Uterine involution, day and variance of first postpartum ovulation in mares treated with progesterone and estradiol-17β for 1 or 2 days postpartum. *Theriogenology*, 57(2), 989–995. https://doi.org/10.1016/s0093-691x(01)00703-8
18. Alamaary, M., Al-Sobayil, F., & Ali, A. (2014). Reproductive performance of Arab mares in the Kingdom of Saudi Arabia. *Tierärztliche Praxis Ausgabe G: Großtiere/Nutztiere*, 42(3), 145–149. https://doi.org/10.1055/s-0038-1623222
19. Ishii, M., Aoki, T., Yamakawa, K., Magata, F., Gojo, C., Ito, K., Kayano, M., & Nambo, Y. (2013). Relationship between the placental retention time and the reproductive performance at the foal heat in Thoroughbred and a comparison with heavy draft. *Journal of Equine Science*, 24(2), 25–29. https://doi.org/10.1294/jes.24.25
20. Aoki, T., Yamakawa, K., & Ishii, M. (2013). Factors affecting gestation length in heavy draft mares. *Journal of Equine Veterinary Science*, 33(6), 437–440. https://doi.org/10.1016/j.jevs.2012.07.011
21. Akourki, A., Echegaray, A., Falceto, M. V., & Mitjana, O. (2017). Factors influencing reproductive efficiency and pregnancy in Pura Raza Española mares. *Veterinární Medicína*, 62(4), 186–191. https://doi.org/10.17221/205/2015-vetmed
22. Mahal, J. S., Honparkhe, M., Kumar, A., & Singh, P. (2020). Conception rates following breeding at foal heat versus induced heat in postpartum indigenous mares. *International Journal of Current Microbiology and Applied Sciences*, 9(4), 1904–1907. https://doi.org/10.20546/ijcmas.2020.904.225
23. Suchitra, B. R., Dinesh, N. M., Yathish, H. M., Anil Kumar, M. C., & Chandraskhekara Murthy, V. (2023). Age related effect on pregnancy rate and pregnancy wastage in thoroughbred mares bred during different heat cycles postpartum under subtropical conditions. *The Indian Journal of Animal Sciences*, 93(4), 349–352. https://doi.org/10.56093/ijans.v93i04.124643
24. Lane, E. A., Bijnen, M. L. J., Osborne, M., More, S. J., Henderson, I. S. F., Duffy, P., & Crowe, M. A. (2016). Key factors affecting reproductive success of thoroughbred mares and stallions on a commercial stud farm. *Reproduction in Domestic Animals*, 51(2), 181–187. https://doi.org/10.1111/rda.12655
25. Rose, B. V., Firth, M., Morris, B., Roach, J. M., Wathes, D. C., Verheyen, K. L. P., & de Mestre, A. M. (2018). Descriptive study of current therapeutic practices, clinical reproductive findings and incidence of pregnancy loss in intensively managed thoroughbred mares. *Animal Reproduction Science*, 188, 74–84. https://doi.org/10.1016/j.anireprosci.2017.11.011
26. Ginther, O. J., Gastal, E. L., Gastal, M. O., & Beg, M. A. (2004). Seasonal influence on equine follicle dynamics. *Animal Reproduction*, 1(1), 31–44.

27. Çil, B., Orkun, K., Şahin, M. O., & Sayım, A. A. (2025). Preovulatory follicle size and reproductive parameters in Arabian mares: A comprehensive analysis. *Turkish Journal of Agriculture - Food Science and Technology*, 13(5), 1123–1129. https://doi.org/10.24925/turjaf.v13i5.1123-1129.7687
28. Dutra, G. A., Ishak, G. M., Pechanova, O., Pechan, T., Peterson, D. G., Jacob, J. C. F., Willard, S. T., Ryan, P. L., Gastal, E. L., & Feugang, J. M. (2019). Seasonal variation in equine follicular fluid proteome. *Reproductive Biology and Endocrinology*, 17, 29. https://doi.org/10.1186/s12958-019-0473-z

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