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EFFECTS OF HEAT STRESS ON SEXUAL BEHAVIOR IN HEIFERS

STUDIUL COMPORTAMENTULUI SEXUAL LA JUNINCI ÎN CONDIŢII DE STRES TERMIC

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High ambient temperatures affect the secretion of sexual hormones in cows and heifers. As a result, the frequency of silent estrus can reach a high level during summer. In order to analyze the effects of heat stress on sexual behavior in Black and White Romanian heifers, a research has been conducted on four groups of animals in the pre- and post-AI interval. During spring, in conditions of thermal comfort and under the stimulating influence of increasing photoperiod, 83.3% of the heifers showed clear signs of estrus. Exposure to temperatures of 36-42○C by day and 21-31○C by night caused anoestrus: the heifers did not respond to repeated estrus-induction treatment. When hot days (33-38○C) alternated with tolerable temperatures by night (18-21○C), a normal expression of estrus was noticed in 16.7% of the animals, while 33.3% experienced weak estrus and 50% did not exhibit sexual behavior. In conditions of moderate thermal stress, with peaks of daily temperature ranging from 28 to 34○C, clear signs of estrus were detected in 25% of the heifers and weak symptoms in 41.7%, while 33.3% had silent heat, clinically diagnosed. The circadian profile of behavior changes in heat-stressed heifers, whose sexual activity shifts to night time and to the early hours of the morning.
Keywords: estrus behavior, heat stress, heifers

Introduction

The detrimental effect of high ambient temperatures on productive and reproductive processes in dairy cattle is well documented. When the environmental temperature rises above the upper critical threshold (27-28○C), the nutritional status and energy balance are impaired. Thermolysis leads to metabolic changes that reduce the food intake: this is the main cause of the decline of milk production. Moreover, the increased blood levels of catecholamine inhibit the release of oxytocin, which partially controls milk ejection (Veissier, 2000). High-producing dairy cows are extremely vulnerable to heat stress, as well as cows during peak lactation. Increased respiratory and cardiac rhythms, changes in hormone secretion, digestive trouble, the wide fluctuation of leukocytes etc. are other responses to

thermal stress. When the environmental temperature is near or above the body temperature, the animals face the risk of heat shock and milk production can decrease by as much as 50 percent.

The reproductive function is also severely affected by heat stress (Dunlap, 1971; Monty, 1974; Drost, 1999; Sönmez, 2005). Hyperthermal stress increases body temperature (Gwazdauskas, 1981) and compromises the uterine environment, thus reducing the likelihood of embryo implantation. It also leads to a high rate of embryonic mortality: this is one of the main causes of poor reproductive performance during summer (Rivera, 2001). Under the influence of high ambient temperatures, the endocrine interactions are impaired, the follicular development pattern changes, the quality of oocytes and embryos decreases (Madan, 1973; Wolfenson, 2000). Despite the fact that several authors have studied this issue, the mechanisms through which thermal stress influences the function of the hypothalamic-hypophyseal-ovarian axis are not completely elucidated. It seems that FSH secretion from the pituitary gland is not impaired in animals exposed to high ambient temperatures. In contrast, a clear reduction in the pulse and amplitude of LH release has been reported (Gilad, 1993; Roth, 2000); hence the higher incidence of silent heat and anoestrus in cows and heifers during summer.

Research conducted in Romania shows that chronic thermal stress leads to delayed ovulation, low conception rate, as well as to a higher rate of abortions. Parturition is usually more difficult in cows exposed to heat stress during the last three months of pregnancy; also, the calf's weight is lower. Chronic heat stress affects the immune system, which increases the incidence of various infections (Bolocan, 2000; Bolocan, 2001).

It is well known that a successful management of cattle reproduction depends on the accurate detection of estrus. But a very large number of cows and heifers experience indistinct or silent estrus when exposed to heat stress; as a consequence, the observation of sexual behavior loses very much of its effectiveness during the summer. The goal of our study is to compare the degree, the pattern and the circadian profile of sexual activities in heifers under thermal neutrality and under heat stress. Our findings are of practical help for farmers; in order to reduce the decline of the pregnancy rate, the traditional schedule of estrus detection and insemination should be changed during summer.

Materials and Methods

Forty-eight Romanian Black and White heifers, 16 to 19 months of age and weighing 368 to 416 kg, were used to compare the estrus behavior under different environmental temperature conditions. The research was conducted during spring and summer on four groups of animals, each of them being monitored 8 days in the pre- and post-AI interval. Each group consisted of 12 heifers in good health and with a normal development of the reproductive apparatus**.** All groups were kept in the open, in the paddocks of Saftica Farm. The heifers were fed a

standard diet, in accordance with the nutritional requirements of their age and weight category.

Group I served as control group. The heifers were monitored in April, in a thermo-neutral environment. The maximum daily temperatures ranged from 16 to 25°C and the minimum temperatures from 7 to 11°C, with an overall average of 15°C. Group II was exposed to intense diurnal and nocturnal heat stress (36-42°C by day and 21-31°C by night). The heifers were monitored in July, in a period with extremely hot weather and no wind, with values of THI rising above the threshold of thermal comfort (72) in the daytime and in most of the nights and with high ground temperatures (65-75°C). The heifers were kept in a paddock providing neither natural nor artificial shade. Group III was monitored in early August. The heifers were directly exposed to solar radiation in a shadeless paddock. They experienced intense diurnal heat stress (33-38°C), but the temperature decreased to 18-21°C during the nights. The wind blew intermittently during the pre- and post-AI period, which contributed to a slight cooling of the animals. Group IV was monitored at the end of August. The heifers were kept in a paddock provided with sunshade. They experienced a moderate heat stress, since the peaks of daily temperature under the sunshade ranged from 28 to 34°C and the temperature decreased to 15-21°C by night. The variations of temperature and THI during the four phases of the research, recorded with the thermo hydrograph, are shown in Table 1.

Table 1.

Daily climatic variables during the four research phases (temperature and THI)

Micro-climatic conditions	Temperature (°C)			Temperature-Humidity Index	
Phase I: thermo-neutrality	Average max. temp.	Average min. temp.	Av. temp. per phase	Average max.	Average min.
	18.1	8.9	15	68.2	60.6
Phase II: intense diurnal and nocturnal heat stress	Average max. temp.	Average min. temp.	Av. temp. per phase	Average max.	Average min.
	39.7	26.2	31.7	89.9	75.4
Phase III: intense diurnal heat stress	Average max. temp.	Average min. temp.	Av. temp. per phase	Average max.	Average min.
	35.6	19.3	25.4	87.3	70.6
Phase IV: moderate heat stress	Average max. temp.	Average min. temp.	Av. temp. per phase	Average max.	Average min.
	31.1	17.9	23.2	78.4	66.1

The heifers in all groups received prostaglandin 2α (2ml/female) for synchronizing estrus and ovulation. As the treatment produced no effect in the heifers of Group II, exposed to severe heat stress, these animals were given an increased dose of prostaglandin 2α (3ml), 72 hours after the first injection. The animals in each group were observed continually for eight days, before and after AI. The heifers which didn't display signs of heat were repeatedly examined by transrectal palpation. Respiration rates and rectal temperatures were determined daily at 7 a.m. and 4 p.m.

The heifers in estrus, detected by visual observation and/or by clinical examination, were inseminated twice, in the morning and in the evening. The inseminations were performed using semen from the same bull.

Results and Discussion

Exposure to high temperatures generated significant changes in the behavioral patterns of heifers. Common symptoms of heat stress were noticed: decrease of dry matter intake, polypnea and open mouth breathing with the tongue hanging out, hyper salivation, shortened sleep episodes (10-20 minutes compared to the normal duration of 30-35 minutes) etc. However, the heifers did not display the lethargic behavior that is frequently noticed in dairy cows when ambient temperatures exceed 35-36○C. Previous findings and our own observations suggest that heifers possess a greater capacity of adaptation to heat stress than adult animals.

Respiration rate (RR) and rectal temperature (RT) are commonly used as indicators of thermal status. The average values of RR and RT, recorded in the morning and in the afternoon, are shown in Table 2. As a response to increasing ambient temperatures, the respiration rates at 4 p.m. were 3-3.5 times higher than at 7 a.m. in Groups II, III and IV and the rectal temperatures raised 1.5 to 2 degrees above the normal value; these data show a high level of stress. By comparing the groups exposed to thermal stress with Group I, we found a very significant difference ($p<0.001$) for both parameters.

Table 2.

Respiratory rates and rectal temperatures in heifers exposed to various degrees of heat stress

	Average values of RT (○C)		**Average RR (breaths/minute)**	
	At 7 a.m.	At 4 p.m.	At 7 a.m.	At 4 p.m.
Gr. I	38.11 ± 0.12	38.73 ± 0.17	29.5 ± 3.1	36.3 ± 3.54
Gr. II	39.0 ± 0.56	40.1 ± 0.41	49.5 ± 3.3	117 ± 10.26
Gr. III	38.4 ± 0.45	39.7 ± 0.25	38. 9 ± 3.1	107 ± 5.74
Gr. IV	38.2 ± 0.29	39.6 ± 0.20	34.4 ± 3.9	96 ± 9.89

In thermo-neutral conditions, ten of twelve heifers in Group I displayed clear signs of estrus. The intensity of estrus diminished considerably in the groups exposed to high summer temperatures. The influence of micro-climatic factors was dramatic in Group II, monitored in a windless period with extremely high values of THI: none of the heifers showed estrus symptoms, even after the second administration of prostaglandins. In these cases, the clinical examination ruled out the hypothesis of "silent heat"; it is more likely that the perturbation of endocrine mechanisms has led to anoestrus. In Group III, watched in a period when hot days alternated with somewhat cooler nights, normal expression of estrus was observed in two heifers, while four heifers experienced weak estrus and the other six did not display signs of sexual behavior. The onset of estrus was clinically diagnosed in two of these six heifers. In Group IV, distinct signs of estrus were detected in three heifers and weak symptoms in another five, while four animals experienced silent heat, diagnosed by transrectal palpation (Figure 1).

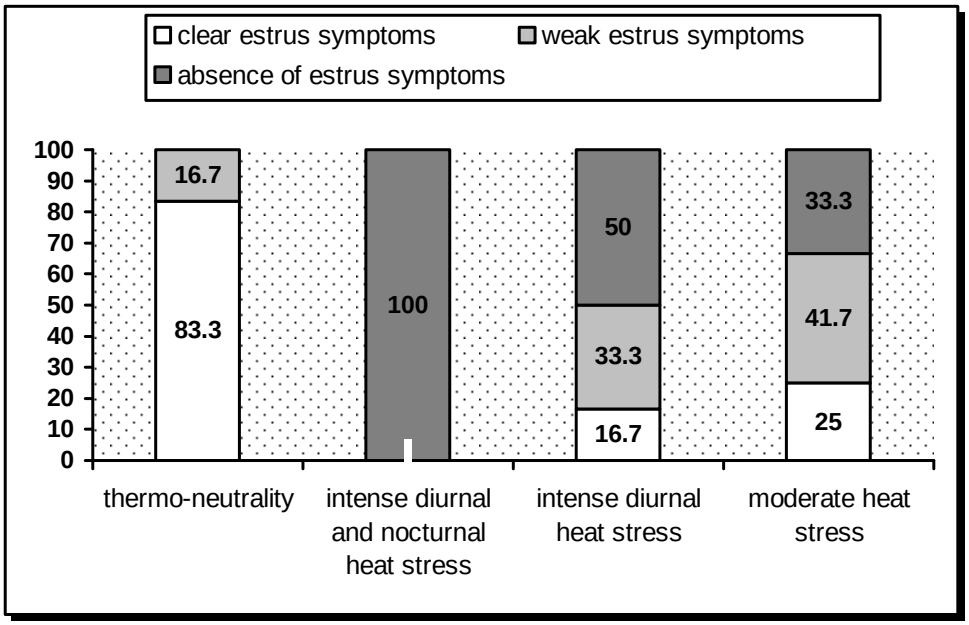

Figure 1. The influence of heat stress on estrus behavior in heifers

Standing to be mounted by another animal is the most conclusive sign of the estrus onset. In Group II, no mounting activity was noticed, while in Group III the mounts were extremely rare and often incomplete: the animals interacted more by rubbing and licking. A relatively larger number of mounts was observed in Group IV; the heifers exposed to moderate thermal stress and protected from the sun

showed more interest for sexual interaction. However, our observations suggest that exposure to temperatures 4 to 6 degrees above the upper level of thermal neutrality changes the circadian profile of sexual behavior. The daily distribution of mounting activity in Group IV, compared to that in Group I, shows that sexual activity in heat-stressed heifers shifts to night time and to the early hours of the morning, when the animals partially recover from the day's heat (Figure 2 and Figure 3).

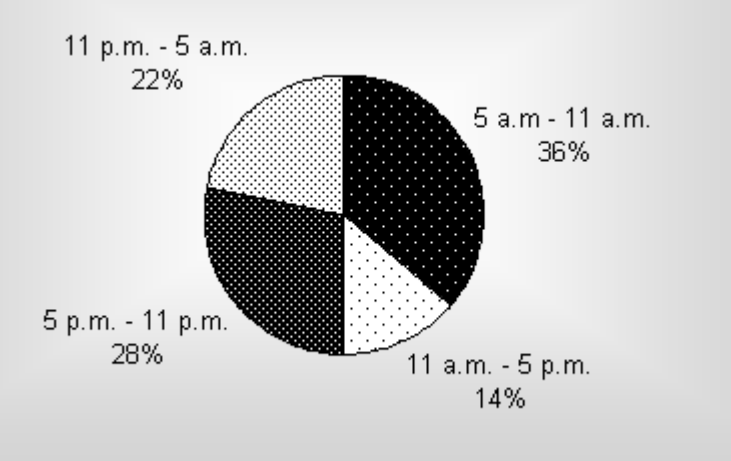

Figure 2. Average daily distribution of mounting activity in heifers in a thermo-neutral environment (Group I)

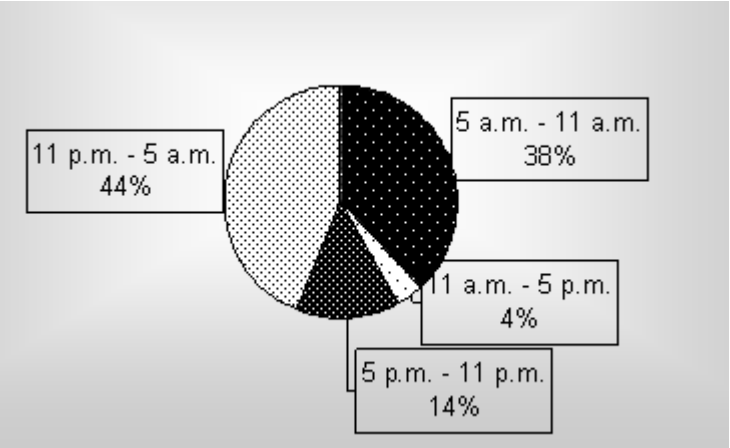

Figure 3. Average daily distribution of mounting activity in heifers exposed to moderate heat stress (Group IV)

Conclusions

The onset of estrus in heifers, as well as its intensity, is adversely influenced by heat stress. To maximize detection of estrus in summer, heifers should be monitored as closely as possible early in the morning and late at night, when sexual activity is more intense. Since the mounts occur very rarely or not at all, visual observation of animals should be done by well-trained farm workers, able to detect the secondary signs of estrus: restlessness, reddened vulva and clear mucus discharge, chin pressing on other animals, lip curling etc. Estrus-induction treatment and examination of heifers by transectal palpation are strongly recommended. To facilitate the fecundation, AI must be performed early in the morning, 5-6 hours before the body temperature begins to increase under the influence of rising environmental temperature.

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