Animal welfare, etológia és tartástechnológia

Animal welfare, ethology and housing systems

Volume 4 Issue 2

Különszám

Gödöllő
2008

EFFECT OF STABLE MICROCLIMATE ON MILK PRODUCTION OF HOLSTEIN COWS ON THE 2nd AND 3rd LACTATION

Falta Daniel, Walterová Lucie, Skýpala Martin, Chládek Gustav

Mendel University of Agriculture and Forestry Brno, Faculty of Agronomy
Department of animal breeding
613 00 Brno (CZ), Zemedelska 1
Falta.Daniel@seznam.cz

Abstract

Aim of this paper was to evaluate the effect of stable microclimate on milk production of thirty high–producing Holstein cows on 2nd or 3rd lactation. Cows were stabled together in same conditions in loose housing stable with bedding. As microclimatic factors were monitored air temperature –T (ºC), relative humidity –RH (%) and counted temperature–humidity index –THI. The experiment was carried out in July (2007) and the whole month was divided into three periods (P1 12 days; P2 11 days; P3 8 days). There were recorded 7 summers and 1 tropical day in the stable. RH varied from 40 to 80%, and THI were 7 days above 72. The mean difference between milk yields (kg/d) was only +1.0 kg in cows on 3rd lactation compared to cows on 2nd lactation. We have found that when the temperature in stable exceeds 21ºC up to the 30ºC (P2) with RH from 45% to 69% and THI from 66 to 79, the effective temperature was above the comfort zone for high–producing dairy cows. This event was accompanied by the falling of daily milk yield. In this period (P2) has been found statistically non-significant higher (P>0.05) downturn in milk production (–3.7 kg/d, –10.1%) at cows on 3rd lactation compared with at cows on 2nd lactation (–3.0 kg/d, –8.3%). Nevertheless if occurred turnover of temperature towards 20ºC milk production raised but not onto prior values. The negative impact by heat stress was more distinctly in cows on higher lactation.

Key words: cows, milk production, stable, temperature, relative humidity, THI, heat stress

Introduction

From a global perspective, Czech Republic (CZ) lies in the temperate zone with a regular distribution of precipitation throughout the year. Prevailing circulation conditions in Central Europe and the orographic conditions of our territory determine the typical distribution of climate in CZ, where a warmer and drier climate is typical for lowland areas and a colder and wetter climate for highland and mountain areas (*Tolasz et al.,* 2007).

Problems with global warming are worldwide discussed. It is evidently apparent that husbandry conditions belong to its influence. Relatively specific problem is negative impact of high temperature on cattle in conditions of stable microclimate. Also *Hahn* (1995) presents that global warming has the potential to exacerbate impact of summer weather on vulnerable animals.

The most sensitive cattle categories to high ambient temperature are lactating dairy cows, because they produce much more heat than non-lactating cows, especially in an early stage of lactation (*Koubková et al.,* 2002).

Lactating dairy cows create a large quantity of metabolic heat and accumulate additional heat from radiant energy. Heat production and accumulation, coupled with compromised cooling capability because of environmental conditions, causes heat load in the cow to increase to the point that body temperature rises, intake declines and ultimately the cows productivity declines (*West,* 2003).

Hot weather can strongly affect animal bioenergetics, and has negative impact on animal performance and well-being. Reductions in feed intake, growth or milk efficiency are commonly reported in heat-stressed cattle (*Hahn,* 1999). High dry-bulb temperature and humidity, in combination with a solar load and low movement, can exceed stressor limits with resulting loss of productivity and even death of the animal (*Eigenberg et al.*, 2005).

The effects of the ambient environment on cow performance have been measured by establishing critical ambient temperatures for the cow, an equivalent temperature index incorporating temperature, humidity and air velocity, and temperature–humidity index (THI), which incorporates the combined effects of temperature and relative humidity (*West*, 2003).

The objective was to analyze the affect of stable microclimate during one month in summer (*July,* 2007). There were monitored stable temperature, humidity and THI (temperature–humidity index) as microclimatic parameters which were influenced by hot weather.

Materials and methods

It were evaluated the effect of stable microclimate in summer on milk production at thirty Holstein cows placed on university farm in *Zabcice* (CZ) lies in lowland area (49°0'4"North, 16°36'East, 179 m of altitude). Cows were divided according to parity of lactation into 2 groups; 15 cows on 2^{nd} and 15 cows on 3^{rd} lactation. All thirty cows were kept together in identical conditions in loose housing stable with bedding and fed ad libitum a complete ration. Cows were milked twice daily at 4.00 and 16.00 h.

In July 2007 were monitored parameters of stable microclimate and daily milk yield. As stable microclimatic factors were monitored air temperature (ºC), relative humidity (%) and temperature–humidity index (THI).

Temperature and humidity was obtained by six data loggers (HOBO) placed in withers area in the stable. Than was counted average daily temperature and humidity as arithmetic mean from measured values in 15 minutes interval. THI was calculated by adapted equation of *Hahn* (1999) cited *Eigenberg et al*. (2005):

$$THI = 0.8\, t_{db} + (t_{db} - 14.4) * RH/100 + 46.4,$$

where t_{db} = daily average dry bulb temperature and RH = relative humidity in decimal form.

The whole month July was divided into three periods (P1 12 days; P2 11 days; P3 8 days) according to fluctuation of average daily temperature (see Fig. 1). Comparison between milk production changes of cows on 2nd and 3rd lactation were evaluated by standard statistical methods with using program Statistica 8.0.

Results and discussion

Mean, minimum and maximum temperature, relative humidity (RH) and calculated THI by the particular experimental periods are shown in *Table 1.* The first period (P1) in duration 12 days was characterized by a lack of heat stress conditions; mean, minimum (T_{min}) and maximum temperature (T_{max}) and mean RH were 19.8 ,15.8 and 23.9 ºC and 63.6%, respectively. Average THI was 65.4 and maximum (71.6) not exceed the critical comfort level of 72, which is presented by many authors (e.g.: *Armstrong*, 1994; *Bouraoui*, 2002).

Table 1. **Average values of microclimatic parameters in particular periods (in July 2007)**

Period	Units	P1	P2	P3
Length	[days]	12	11	8
Temperature	[°C]	19.8	26.5	21.2
(Min. – max.)		(15.8–23.9)	(19.7–30.1)	(17.3–24.3)
RH	[%]	63.6	55.9	55.5
(Min. – max.)		(41.7–81.6)	(44.7–69.4)	(47.5–66.2)
THI	[-]	65.4	74.2	67.1
(Min. – max.)		(60.2–71.6)	(65.8–78.9)	(61.8–70.5)

In the second 11 days long period (P2) was characterized by mean temperature 26.5 ºC, where T_{max} reached 30.1 ºC. The RH was on the average level in 55.9% and average THI was 74.2. THI at maximum reached 78.9 which means very stressed period for animals. *Hahn* (1999) stated when conditions reach THI levels of 75 or above, is concerned even dangerous period, particularly when air temperatures may remain above 23 ºC at night.

The third period (P3) was 8 days long. The mean temperature, T_{min} and T_{max} and RH were 21.2, 17.3 and 24.3 and 55.5%. This period was regressing in all measured parameters in the stable. Average THI was 67.1 with maximum at 70.5. Must be accented that this period was shorter and parameters represented in average values was unequal to others periods.

The range for lactating dairy cows is estimated to be from -0.5 to 20 ºC (*Johnson*, 1987), while *Berman et al.* (1985) indicated that the upper critical air temp. for dairy cows is 25 to 26 ºC.

The results in *Table 2* showed in first part the amount of milk produced by cows on 2nd and 3rd lactation across the periods. In period P1 was average daily milk production 37.2 and 35.9kg in P2 where were observed heat stress conditions, occurred fall on 32.9 and 33.5kg which continued fewer in third period P3 on 32.0 and 33.1kg at cows on 2nd and 3rd lactation, respectively.

***Table 2.* Average daily milk production and changes in particular periods**

Period	Units	P1	P2	P3
Length	[days]	12	11	8
2nd lactation	[Kg]	35.9	32.9	32.0
Min. – max.		(35.3–36.6)	(28.9–36.8)	(30.5–33.2)
3rd lactation	[Kg]	37.2	33.5	33.1
Min. – max.		(36.0–38.0)	(28.3–38.3)	(31.3–34.7)
Changes in milk production in kg (%)		P1 to P2	P2 to P3	P1 to P3
2nd lactation	–	-3.0 (8.3%)	-0.9 (2.7%)	-3.9 (10.9%)
3rd lactation	–	-3.7 (10.1%)	-0.4 (1.2%)	-4.1 (11.0%)

N.S. = non significant (P>0.05)

The second part of the *Table 2* demonstrated fall and rise in production among particular periods. The greatest fall was registered between P1 and P2 by 3.0 (8.3%) and 3.7kg/d (10.1%) at cows on 2nd and 3rd lactation, respectively. Analysis of variance has found that parity of lactation has no statistical significant influence (P>0.05) on fall in milk production. Although it were expected rising in P3 occurred small decrease in average values. It could be caused by short duration of this period. In total, the difference in milk production between P1 and P3 were 3.9 (10.9%) and 4.1kg (11.0%) at cows on 2nd and 3rd lactation, respectively.

Day to day average daily milk production in relation to temperature, humidity and THI variations across each period are given in *Figures 1, 2 and 3*. *Figure 1* illustrates the effect of high temperature on milk production at cows on 2nd and 3rd lactation. Temperature above 21 °C appeared to be limited for exceed comfort zone for dairy cows. The relationship between milk production and relative humidity are presented in *Figure 2*. The RH values fluctuated during whole month and in P2 had descending tendency.

From *Figure 2* is evidently, that RH has less negatively influence on milk production than temperature. *Figure 3* shows effect of THI on milk production. It has been found 7 days above 72 in July. The THI curve copies more or less the shape of temperature curve. Our results are generally according to conclusions for example *Koubkova et al.* (2002).

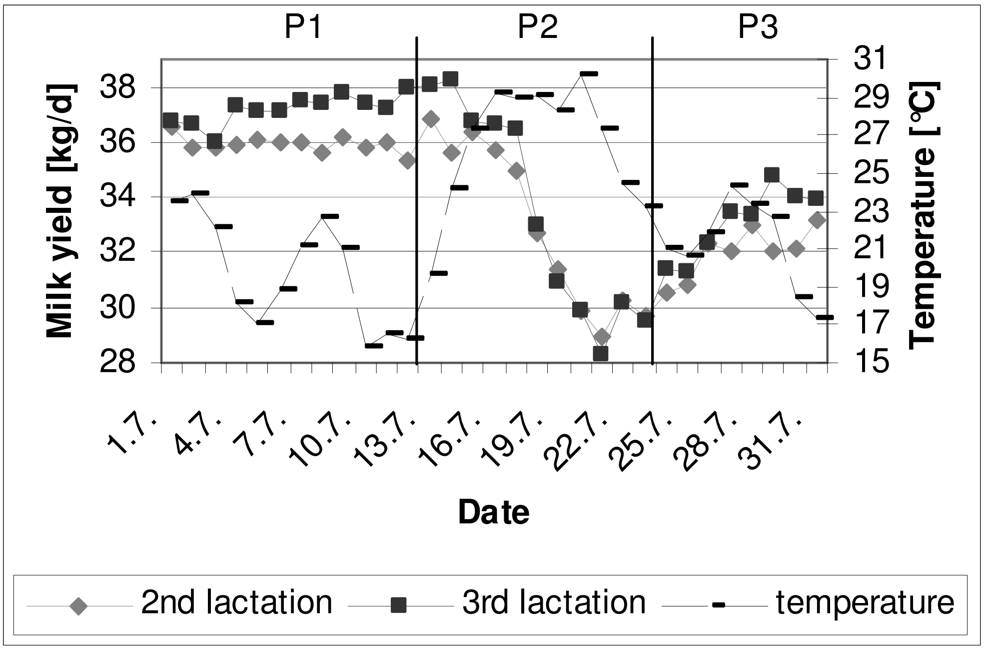

***Figure 1.* The effect of temperature on milk production at cows on the 2nd and 3rd lactation**

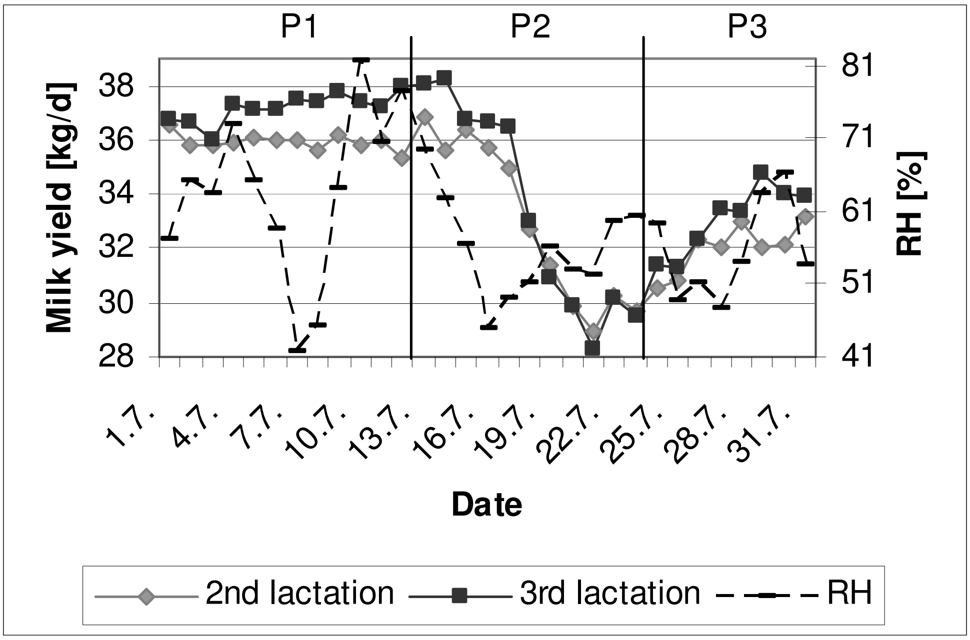

Figure 2. **The effect of relative humidity (RH) on milk production at cows on the 2nd and 3rd lactation**

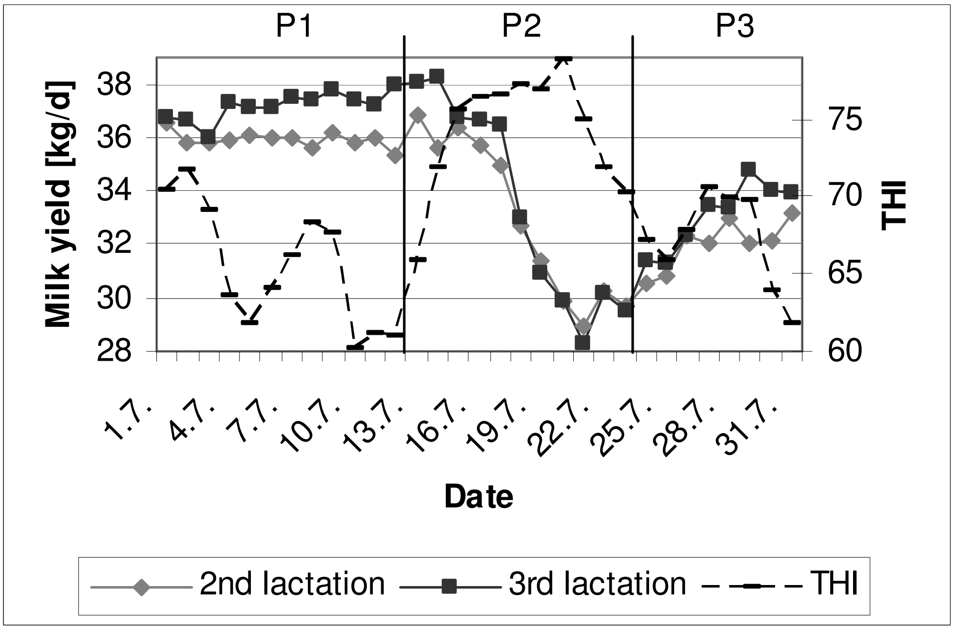

Figure 3. **The effect of temperature–humidity index (THI) on milk production at cows on the 2nd and 3rd lactation**

Conclusion

The effect of microclimate in stable in July (2007) has negative partake in milk production of Holsteins cows. THI values reached the 72 or above the milk production decreased by 4kg. Decreasing tendency was higher at cows on 3rd lactation compared with cows on 2nd lactation.

Acknowledgment

This study was supported by the Research plan No. MSM6215648905 “Biological and technological aspects of sustainability of controlled ecosystems and their adaptability to climate change“, which is financed by the Ministry of Education, Youth and Sports of the Czech Republic.

References

Armstrong, D.V. (1994): Heat stress interaction with shade and cooling. J. Dairy Sci., 77. 2044-2050.

Berman, A., Folman, Y., Kaim, M., Mamen, M., Herz, Z., Wolfenson, D., Arieli, A., Graber, Y. (1985): Upper critical temperatures and forced ventilation effects for high-yielding dairy cows in a subtropical climate. J. Dairy Sci., 68. 1488-1495.

Bouraoui, R., Lahmar, M., Majdoub, A., Djemali, M., Belyea, R. (2002): The relationship of temperature–humidity index with milk production of dairy cows in a Mediterranean climate. Anim. Res., 51. 479-491.

Eigenberg, R.A., Brown-Brandl, T.M., Nienaber, J.A., Hahn, G.L. (2005): Dynamic Response Indicators of Heat Stress in Shaded and Non-shaded Feedlot Cattle, Part 2: Predictive Relationships. Biosystems Engineering, 91. 1. 111–118.

Hahn, G.L.(1999): Dynamic responses of cattle to thermal heat loads. J. Anim. Sci.,

Johnson, H.D. (1987): Bioclimatology and the Adaptation of Livestock. World Animal Science

Koubková, M., Knížková, I., Kunc, P., Hartlová, H., Flusser, J., Doležal, O. (2002): Influence of high environmental temperatures and evaporative cooling on some physiological, hematological and biochemical parameters in high-yielding dairy cows. Czech J. Anim. Sci., 47. 8. 309–318.

Tolasz, R. et al. (2007): Climate Atlas of Czechia. EHMÚ, Palacký University Olomouc, Praha – Olomouc

West, J.W. (2003): Effects of Heat-Stress on Production in Dairy Cattle. J. Dairy Sci., 86. 2131–2144.