CHAPTER V

DISCUSSION

Temperature, relative humidity and THI

Different breeds of cattles have different ideal environment temperatures, e.g. temperature for Holstein cattle should not exceed 24^{o} C while Jerseys are more tolerant and can resistance a temperature up to 27^{o} C (Yeck and Stewart, 1959). During the day, maximum minimum and average temperatures in NEVAP of this study were 6.7, 1.4 and 3.1°C higher than in EVAP. On the other hand, average RH in EVAP was higher than when compared with NEVAP. As a result average THI during the day in both housing system was only 4 units difference. RH in EVAP was always high even during the day. Meanwhile RH in NEVAP also started to decrease after sunlight. THI is widely used in hot areas all over the world to assess the impact of heat stress on dairy cow. If the heat stress level classified by Hahn and Mader (1997) is used, it can be concluded that cows in EVAP were in the mild stress. While cows in NEVAP were in the medium stress. Cows in EVAP were suffered mainly from high RH; on the other hand cows in NEVAP experienced heat stress through high ambient temperature. It can be concluded from this study that all animals in this experiment were in the situation of heat stress at different level of severity.

Dry matter intake, milk production and productive performance

The processes associated with maintenance, digestion, activity, metabolism and production create a large amount of heat. High ambient temperature, RH and radiant energy compromise the ability of the lactating dairy cow to dissipate heat. Therefore, animals would adapt themselves by reduced feed intake, decrease their activities, increased in RR including peripheral blood flow and sweating to alleviate those problems. These responses have a deleterious effect on both production and physiological status of the dairy cows (Bouraoui et al., 2002). Although all animals in the present study were affected by the situation of heat stress, environmental temperature. THI of NEVAP was higher than EVAP, especially during the day when average THI in both housing were higher than 74, the critical value for health of dairy cattle (Hahn and Mader, 1997). It was likely that THI of EVAP might be reduced below 74 during the nighttime. As a result, cows in EVAP may compensate their consumption by eating more during the nighttime. Meanwhile THI in NEVAP might be still higher than 74 due to the increment of RH at night. Cows in NEVAP were still in heat stressed condition and had less change to compensate their consumption during the cooling period. Animals in EVAP consumed 22.7% more feed than animals in NEVAP. DMI and DMI/%BW were increased by 2.1 kg and 0.5%, respectively. The high consumption of cows in EVAP had direct effect on milk production. Cows in EVAP produced 4.3 kg of milk and 4.3 kg of 4% FCM more than those of cows in NEVAP ($P<0.01$). Cows in EVAP were responded better in performance and productivity than cows in NEVAP. This is consistent with the studied of Bouraoui et al. (2002) that found daily THI was negatively correlated to milk yield ($r = -0.76$) and feed intake ($r = -0.24$). When THI value increased from 68 (spring) to 78 (summer), milk production decreased by 21%. Milk yield decreased by 0.41 kg per cow per day for each point of increase of the THI values above 69. According to Johnson (1985) and Du Preez et al. (1990) showed that milk production was not affected by heat stress when THI values were between 35 and 72. However, milk production and feed intake began to decline when THI reached 72 and continued to decline sharply at a THI values at 76 or greater.

Shearer and Beede (1990) reported that heat stress had the influence on milk composition because of the reduction in feed intake, which was the main response of dairy cattle to high environmental temperatures (Collier et al., 1981). There were no significant differences in milk compositions in this study, but cows in EVAP tended to produce better milk compositions than those of cows in NEVAP. A similar response was also reported by Strickland et al. (1989) and Abelardo et al. (2002). They did not find an effect of a cooling system on milk fat percentage, but did observe an increase in protein percent in the cooling group.

Physiological change and water intake

Indicators of heat stress in cattle have been shown by increases RT, RR and pulse rate (Lemerle and Goddard, 1986; Itoh et al., 1998 and Marai et al., 1997). RT is a sensitive indicator of thermal balance and may be used to assess the negative effects of hot environments on growth, lactation and reproduction cows (West, 1999). It has been shown that a rise of 1^{o}C or less in RT is enough to reduce intake and production in dairy cows. A cow normally has about 15 -30 breaths/minute and RR of 80 -90 breaths/minute are considered a clear indication of heat stress (Stowell, 2000). Eigenberg et al (1999) reported that RR positively correlated with ambient temperature. In the present study, there were significant differences on RT and RR between cows in EVAP and NEVAP ($P<0.001$). The increase RT and RR during the experimental period of cows in NEVAP compared to EVAP were the characteristic of heat stressed animals. The thermoregulation by increasing evaporative heat loss from upper respiratory passages would be apparent (Thaccher and Collier, 1986). Several studies have shown that evaporative cooled cows had lower RT and RR than those that were not cooled (Abelardo et al., 2002; Armstrong et al., 1993; Chen et al., 1993 and Huber et al., 1994).

Increased water intake is a major physiological reaction to heat stress. Cows need to increase water intake during heat exposure for dissipation of heat through the lungs (respiration) and by sweating. In the present experiment, there were significant differences in water intake and water intake / DMI between NEVAP and EVAP ($P<0.01$). This response would be one of several strategies in maintaing the core body temperature for heat dissipation mechanism. Bernabucci et al. (1999) reported the effect of exposure to high temperature was responsible for increased water intake ($P<0.01$) from 27.55 l/d to 42.61 l/d and reduced DMI ($P<0.01$) from 8.01 to 7.48 kg/d. In this study, dairy cows in NEVAP consumed water more than dairy in EVAP. Water consumption increases sharply as the environmental temperature increase because of greater water losses from sweating and from water vaporization with more rapid respiratory rates (panting), both effects aimed at increasing evaporative cooling for the cow (NRC, 1981).

Milk allantoin

Majority source of protein for ruminants come from fermentation of ruminal bacteria. Microbial protein synthesis in the rumen comprises 60 to 85% of the CP requirements for maintenance. Rumen microbial protein provides a high quality, similar in amino acid profile to milk protein and is highly digestible. Purine derivatives have been used to measure microbial protein synthesis in the rumen. In this study, there were no significant differences on milk allantoin concentrations at am and pm collections and also average value between groups. However, the milk allantoin concentration of EVAP tended to be higher than NEVAP. These results corresponded with DMI that cows in EVAP was higher. A number of studies were reported on the effect of DMI (Lebzien et al., 1993) and energy intake (Giesecke et al., 1994) on the allantoin concentration. They found that milk allantoin was positively correlated with DMI and energy intake. In addition, Valderes et al. (1999) fed diets of different concentrate percentage (20, 35, 50 and 65%) to multiparous Holstein cows. The result showed an increase in the secretion of allantoin in milk increased when the high level of concentrate was offered.

Volatile fatty acid

VFAs are the result of fermentative organic matter (OM) by microbes present in the rumen. Acetic, propionic and butyric acid are the predominant forms of VFA in the rumen. VFA constitute a large proportion of the energy available to the cow (Van Soest, 1982). Declining intake during heat stress reduces the quantity of VFA occur in the rumen because of the reduction of fermentable carbohydrate for bacteria. In the present experiment, there were no significant difference on concentrations of each VFA, total concentration of VFA and A:P ratio. However, acetate, butyric concentrations and the ratio A:P were higher in EVAP. Previous report in VFA showed that heat stressed cattle which were forced-fed via ruminal cannulae to achieve constant intake had reduced total VFA production with altered molar proportions of VFA in comparism with cattle in thermoneutral conditions (Kelly et al., 1967).

Digestibility and rumen passage rate

A variety of factors affect digestibility, e.g. rate of feed consumption, feed quality, nutrient composition and rates of passage of digesta. A number of studies assessing effects of increasing environment temperatures on digestibility have been summarized. In general, in high temperature regions as temperatures rises, digestion of roughages by cattle would increase (Colditz and Kellaway, 1972; McDowell, 1972 and Lippke, 1975). Bernacucci et al. (1999) reported that increased digestibility of DM, NDF and ADF (11.1, 15.2 and 16.6 percent) were apparent when Friesian heifers were exposed to short term of heat stress. In this study, digestion of DM, NDF and ADF were not significant differences between EVAP and NEVAP (P>0.05). But digestibility of nutrient (DM, NDF and ADF) of dairy in EVAP was higher when compared to dairy in NEVAP. Yousri et al. (1977) suggested that high ambient temperature might depress rumen cellulolytic activity. The negative effect of such depression of rumen cellulolytic activity on diet digestibility might have overcome the positive effects caused by the decline in DMI and rumen passage rate (Bernacucci et al., 1999). Other researchers (Lu, 1989; Silanikove and Tadmore, 1989) reported that no variation or a decrease in diet digestibility appeared by ruminants kept under hot environments. Those researchers suggest that it may result from the reduction in blood flow to the digestive tract.

Christopherson and Kennedy (1983) described positive effects of high ambient temperature on diet digestibility. They suggested that the main effect for the reduction in the passage rate of digesta caused by the reduction of gastrointestinal motility that usually more responsible under hot environments. However, in contrast to results of other studies, revealed that hot environment did not depress passage rate or rumen activity via feed intake (Attenbery and Johnson, 1969; Silanikove, 1987 and Warren et al., 1974). The rumen passage rate in the present study was not significant difference between groups (P>0.05). This result was similar to the study Bernabucci et al. (1999) when cows were exposed to long term heat exposure.

Animal Behavior

Climatic conditions have an influence on behavior of dairy cows. Cows tried to avoid activity during the hotter day by concentrating their grazing:eating during relatively cooler period. For example, in the early morning and late afternoon extending into the cool of the evening. Under the conditions of this study, there were no significant difference (P>0.05) behavior on eating time, ruminating time and ruminating/DMI between EVAP and NEVAP. Due to lower level of feed consumption of cows in NEVAP than cows in EVAP, cows in NEVAP tended to spend less time for eating and ruminating. When total chewing time (eating time + ruminating time) was considered, there was significant difference in total chewing (P<0.01) and resting time (P<0.05). According to the present result, lower total chewing time of cows in NEVAP was a result of lower DMI. This finding was in agreement with another study. Prasanpanich et al. (2002) reported that the rising temperature and humidity contributed to the decline in eating activity and that increasing temperature during the day forced the early cessation of grazing time in lactating cow (Cowan et al., 1993).

In conclusion, heat stress can cause many deleterious effects on productive performances of dairy cattle. Reduction of BW, DMI and MY were found in several studies. Also the physiological changes of confined lactating cow were observed. The results from this study suggest that EVAP has the potential to alleviate the stress occurring from heat exposure and reduce the deleterious effect of heat stress in cross-bred lactating cow under the conditions found in Thailand. EVAP could decrease environmental temperature and THI during the day time as compared with conventional housing system. This benefit a role in the reduction of RR and RT. In addition, DMI, DMI/%BW, MY and 4% FCM have been shown to be higher in cows raising in EVAP than those of cows raising in NEVAP.