

Table 12 \ Climatological data collected at 1400 h from the grazing site

Month	DBT (°C)	BGT (°C)	RH (%)	THI
Mar	35.9	40.4	50.8	83.0
Apr	33.1	38.1	67.0	82.8
May	32.8	37.8	57.3	79.8
Mean	33.9	38.8	58.4	81.8

11. Pasture intake of grazing cows was estimated by using chromic oxide (Cr_2O_3) release from a controlled release device (CRD) to estimate the faecal output (FO) of cattle and with in vitro estimates of pasture digestibility to estimate forage intake (Barlow *et al.*, 1988). All cows were dosed with intra-ruminal controlled release Cr_2O_3 capsules (Captec Chrome for cattle, New Zealand) 1 week prior to the measurement. Faecal sampling began 7 days after dosing. Faecal samples were collected twice daily for 5 days. The sampling was repeated the following week. Faecal samples at each sampling were combined to give one sample per cow for each period of 5 days. The samples were oven-dried at 100°C for 36 hours and ground through a 1-mm screen for analysis of chromium (Cr) concentration.

Ground faecal samples were prepared into a solution by employing the reagents and technique described by Costigan and Ellis (1987). The Cr content of faecal solution was determined by the Atomic Absorption Spectrophotometer and calculated for the FO and feed intake by using the formulation of

FO = Cr output from capsule/Cr concentration in faeces,
and Feed intake = FO/(1-digestibility),
 using the IVDM data from the pasture sampling.

12. Statistical analyses on feed intake, milk yield and composition, LW, haematological responses, Thyroid hormones and cortisol level using PROC TTEST were done by SAS (1985).

13. The experiment was conducted at DPO with an experimental period of 58 days starting on March 7 until May 3, 2000. A pre-experimental period of 4 days was allowed for animals to adapt to procedures.

RESULTS AND DISCUSSION

Results

1. Climatological Data

Monthly means of maximum-minimum temperatures, the amount of rainfall, and wind velocity during the experimental period are indicated in Table 11. Means of ET, RH and THI at 0800 h are also shown in Table 11, whilst the same values and BGT at 1400 h were tabulated in Table 12. The grazed animals in both treatments would be expected to suffer from severe heat stress throughout the experiment.

2. Pasture Quality, Meal Concentrate and Pasture Intake

The current experiment was aimed to investigate the clipping effect on physiological changes of dairy cows under outdoor conditions, so means of pasture quality and quantity from both cycles (Table 13) were interpreted for discussion. Then, at the beginning of the current experimentation during weeks 1 to 4, the so-called Cycle 1, pasture on-offer was high in availability but had a low ratio of leaf to stem and was high in dead materials, as shown in Table 13. Slashing after grazing did markedly affect pasture characteristics in Cycle 2 with a decline in pasture yield but an increase in pasture quality, as indicated in Table 13.

Table 13 Means of pasture composition, yield and quality before feeding in either Cycle 1 or Cycle 2

	Cycle 1	Cycle 2	Mean
Leaf (%)	55.6	81.5	68.6
Stem (%)	25.5	12.7	19.1
Dead material (%)	18.9	5.8	12.3
Pasture yield (kgDM/rai)	770.8	496.5	602.3
Sward height (cm)	59.2	51.3	55.3
CP (%)	6.8	17.9	12.4
NDF (%)	70.7	66.5	68.6
ADF (%)	44.6	37.6	41.1
IVDMD (%)	38.7	55.9	47.3

Supplementary feeding was provided with meal concentrate containing 91.6%DM, 76.9%IVDMD and 17.1%CP. Since all the animals in both treatments were grazed in the same paddock, mean pasture intake for each cow was obtained from the chromic oxide technique (Corbett, 1978). Mean pasture intake was not significantly different, being 13.5 ± 2.8 kgDM/beast for the clipped cows and 14.2 ± 3.3 kgDM/beast for the unclipped cows.

3. Grazing Patterns

The grazing activities of both treatments were not significantly different. Two peaks of grazing occurred in both groups, shown in Figure 2a, were similar to the pattern of the outdoor cows in Prasanpanich (2001). They started eating after each milking and absolutely ceased in both groups from 0900 h till 1400 h, due to the high ambient and BG temperatures and THI during the day but more minor grazing peaks in the unclipped animals from 1900 h till 0100 h the next morning were observed.

Ruminating activity in both groups was frequently observed between 2000 h and 0500 h the next morning (Figure 2b). However, no ruminating activity was observed during the day and idling activity occurred during the day from 0900 h to 1400 h (Figure 2c). Panting associated with idling was found from mid morning till late afternoon in both groups.

4. Blood Urea Nitrogen and Blood Glucose

BUN concentration and plasma glucose at either AM or PM feeding were not statistically different between treatments. Only in the control group was plasma glucose value at the PM feeding significantly ($P < 0.01$) higher than that at the AM feeding, whilst no significant differences were found between the AM and PM feedings for either parameter (Table 16).

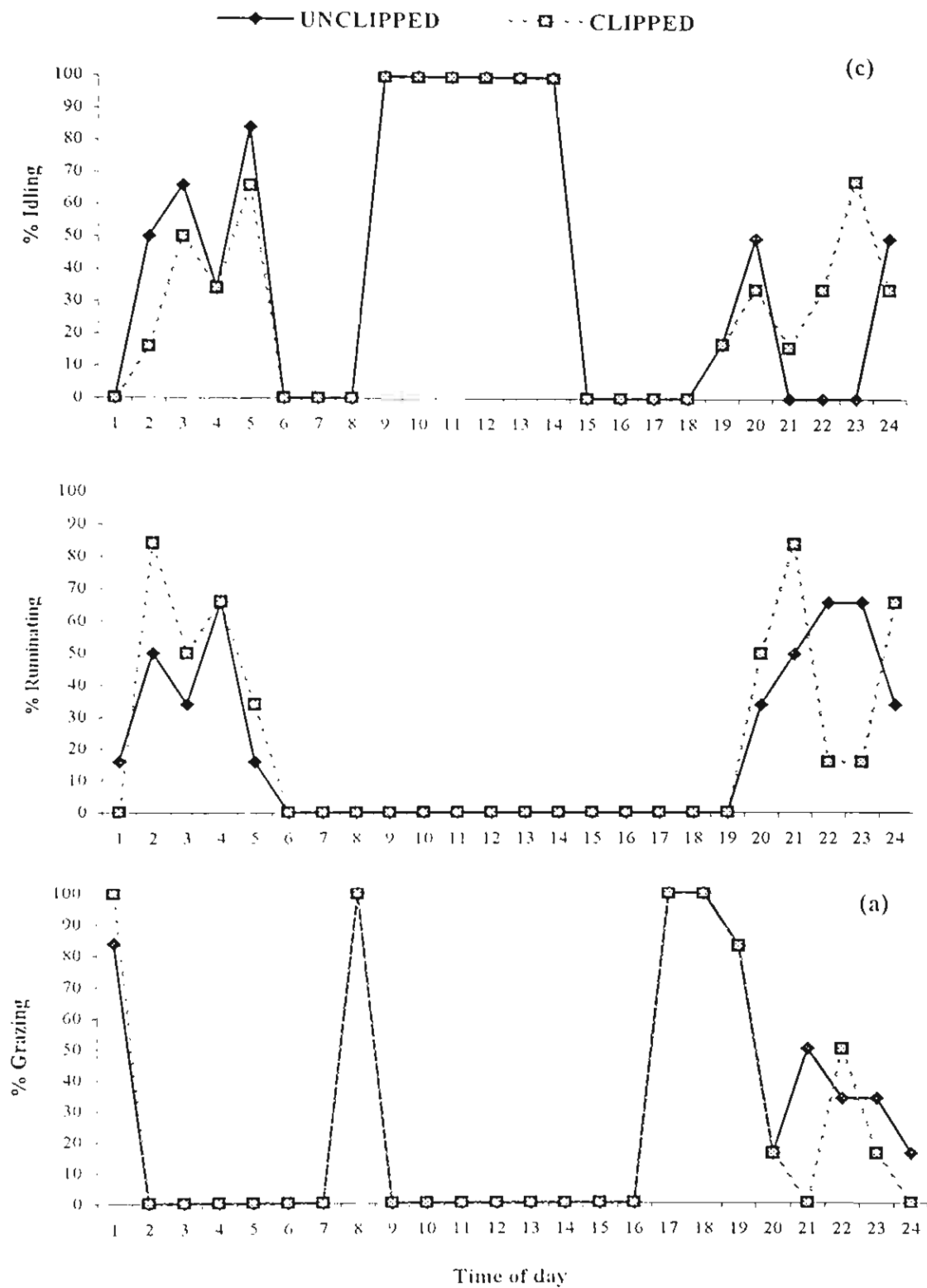


Figure 2 Grazing patterns of animals either coat clipped or unclipped (a) grazing; (b) ruminating; (c) idling. Milking times are indicated by arrows.

Table 16 Mean blood urea nitrogen and glucose of the cows in both treatments at the AM and PM feeding times

	Clipping Group (mg%)	Control Group (mg%)
BUN: AM Feeding	20.4±5.9	17.9±2.8
PM Feeding	22.2±8.1	20.9±3.9
Glucose: AM Feeding	47.0±5.0	48.5±4.2 ^{a*}
PM Feeding	53.8±8.8	59.5±5.4 ^b

Mean±SD

*Means in same column of different parameters with different superscripts are statistically different (P<0.05)

5. Milk Production

Milk yield and milk composition are shown in Table 17. In addition, the fluctuation of FCM yield did show a similar level between both treatments (Figure 3). Average daily milk yield of actual and FCM, and milk composition throughout the experimental period did show no significant differences between treatments.

Table 17 Average milk yield and composition throughout the study

	Clipping Group	Control Group
Actual milk yield (kg/d)	10.1±0.9	10.6±1.2
FCM yield (kg/d)	10.1±1.1	10.8±1.4
Fat (%)	4.0±0.3	4.1±0.4
Protein (%)	2.9±0.1	3.0±0.1
Lactose (%)	4.9±0.2	5.1±0.2
SNF (%)	8.7±0.1	8.7±0.2
TS (%)	12.5±0.2	12.5±0.3

Mean±SD

6. Liveweight Changes

All the animals put on weight at the end of the experiment. Their LW changes in both treatments were not significant different (Table 18).

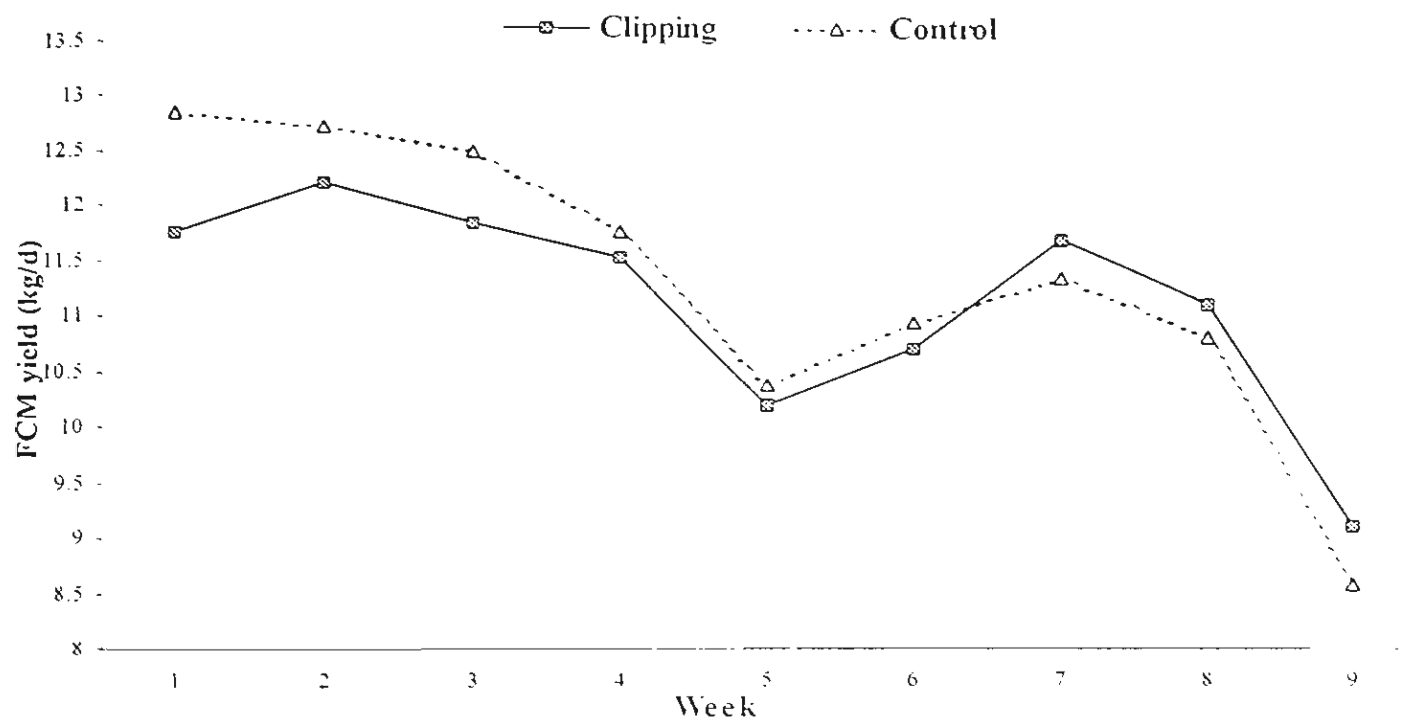


Figure 3 Mean FCM yield per cow in either clipping or control Group throughout the experiment

Table 18 Mean values for initial and final liveweight and fortnightly changes for the two treatments throughout the experiment

	Mean LW (kg/cow)	
	Clipping Group	Control Group
Initial LW	408.0±39.2	408.0±18.3
22/3/00	409.7±45.6	406.0±24.3
10/3/00	416.0±49.1	414.3±21.8
24/4/00	423.0±49.4	419.0±22.3
Final LW	424.0±24.5	429.7±35.8

Mean±SD

Table 19 Physiological responses of cows in either clipping or control Group

Mean for	Clipping Group	Control Group
RT (°C)	40.4±0.44	40.4±0.53
RR (breaths/min)	92.3±13.53	94.8±14.51
ST (°C)	41.3±0.98	41.5±0.85
Ht (%)	24.3±0.77	26.6±1.44
Hb (mg%)	7.0±0.86 ^{a*}	7.6±0.89 ^b
Cortisol (ng/ml)	15.3±4.18	14.5±3.22
T ₃ (ng/ml)	61.3±18.35	66.5±5.09
T ₄ (µg/100ml)	2.8±0.86	2.9±1.12
SR (g/m ² .h ¹)	508.6±201.95	463.2±246.14
HTC (%)	70.7±8.2	67.4±8.3

Mean±SD

*Means in the same row with different superscripts are statistically different (P<0.05)

7. Physiological Changes

The mean coat scores of the animals before and after clipping were 2.83±0.26 and 2.0±0 units, respectively, which were highly significant different (P<0.01). Physiological responses were indicated in Table 19. Average RT and RR of animals in the clipped state were not significantly different between both groups of cows. Variation in SR of the animals in both groups appeared to be high when exposed to solar heat load, affecting the non-significantly different SR between the two groups. Coat

clipping of cows under indoor conditions was generally associated with a reduction in ST as reported by Vajrabukka (1978) and Boonprong (1999), however, ST in the clipped animals in the current study, had a non-significantly different value to their unclipped counterparts. In addition, ST in animals of both groups was higher than their RT under field conditions.

Ht content was non-significantly different between both groups of cows whilst Hb level was significantly lower ($P<0.05$) than those in the unclipped animals. The concentrations of cortisol, T_3 and T_4 were not significantly different between the animals in both groups. Since RT was non-significantly different between treatments, HTC was also found to be non-significantly different between treatments.

Discussion

1. Climatological Data

The current results indicated that the animals studied were subjected to the summer humid conditions (Nuttonson, 1963; Gates, 1968) typical of summer (March, April and May) prior to the onset of the rainy season. Air temperatures at both 0800 h and 1400 h exceeded the acknowledged upper critical temperature of 26°C for dairy cattle (Johnson *et al.*, 1961; Yousef, 1985a). Wind velocity was under the level (of 1.39 m/s; McDowell, 1972) which would be expected to reduce heat stress through increased convective heat loss (Macfarlane, 1968; Elam, 1971). The declining RH from 0800 h to 1400 h appeared to have no effect on either cutaneous evaporation (Bianca, 1968) or RT and RR of cows (Riek and Lee, 1948; Bianca, 1965). However, the mean of BGT at 1400 h would be expected to adversely affect physiological responses in the cows, particularly the solar heat load and BGT (Bond and Kelly, 1955; Gates, 1968) and that was the response observed.

The monthly mean temperature and rainfall were high enough to allow the rapid growth of forage plants (Bryan and Sharpe, 1965; Sweeney and Hopkinson, 1975). The intensity of rainfall during April would be expected to have led to an increase in water content of the forage, thereby limiting the amount of total intake (Holmes and Wilson, 1987; Buxton, 1996).

2. Pasture Characteristics

Pasture slashing was effective in increasing the nutritional status of pasture in terms of higher percentage of leaf, CP content and digestibility for pasture in Cycle 2 (Stobbs, 1971; Davison and Cowan, 1978; Davison *et al.*, 1981). However, pasture yields before and after slashing were slightly over the yield of 576 kgDM/rai recommended by Cowan and O' Grady (1976) for tropical pasture. The animals in both treatments in Cycle 1 appeared to have been affected by low CP content of 6.8% for N metabolism of the rumen microbes (Hennessy, 1980). In fact, the higher CP concentration in Cycle 2 did affect the average CP level of 12.4% throughout the experiment. However, there was a sufficient forage on-offer for them to be able to select a better quality of leaf with supplementary feeding as meal concentrate provided to supply nutrient requirement for milk production (Cowan and Davison, 1983).

The higher NDF and ADF fractions were related to the high proportion of stem and dead material components, and with low IVDMD, indicating that there is a rise in the fibre content when pasture matures (Minson, 1982a; Leng, 1984) with higher NDF and ADF contents than those from Walker *et al.* (1996). Pasture containing higher NDF and ADF contents, as did the stem which is likely to affect the digestibility (Minson, 1982b) and intake, was obviously due to high proportion of stem and dead materials. Since pasture was previously used with no subsequent fertilisation and irrigation, the sward height and a high proportion of dead material would have a depressing effect on intake (Whiteman, 1980; Minson, 1982b). Lower sward height and pasture yield as resulted from slashing resulted in more nutritious feed with a higher leaf percentage (Cowan *et al.*, 1986; Buchanan *et al.*, 1985).

3. Eating Patterns and Feed Intake

The overall pattern of grazing activity recorded was thus similar to the general patterns which have been recorded in dairy cows under a variety of conditions (Webb *et al.*, 1966; Winter *et al.*, 1980; Lefcourt and Schmidtman, 1988; Prasanpanich *et al.*, 2000). It is considered that the rising temperature and THI (Tables 11 and 12) experienced by both groups contributed to the decline in eating activity observed between 0900h to 1400h and that increasing solar radiation as indicated by high BG temperature forced the early cessation of grazing in both Groups (Bianca, 1965; Cowan *et al.*, 1993). Minor grazing activity in both groups was found to compensate for the reduced morning grazing activity during night time which appeared to be considerably higher than that during the day probably due to the cooler conditions (Ree *et al.*, 1972; Cowan *et al.*, 1993).

No ruminating activity in both groups was found from 0900 h till 1400 h due to a rising temperature causing a cessation of grazing activity (McDowell, 1972; Christopherson, 1985) whilst the incidence of idling association with open-mouth breathing and a protruded tongue with drooling (McDowell, 1972; Winter *et al.*, 1980; Shearer and Beede, 1990) increased. However, ruminating activity was observed more frequently in both groups after evening peak and minor peaks of grazing from 2000 h till 0500 h the next morning (Albright and Arave, 1997). Since eating and ruminating are major contributors to the passage of large particles of

forage eaten (McLeod and Minson, 1988), they started ruminating activity when they finished grazing (Hafez and Bouissou, 1975).

4. Feed Intake

The current result was in contrast to Boonprong (1999) who found higher roughage intake in the clipped cows to the unclipped cows under indoor conditions. The clipped animals under indoor conditions are not only protected from excessive heat gain and heat stress (Fuquay, 1981; Armstrong, 1994) but also have a beneficial effect on their thermal balance due to improvement in cutaneous evaporation reducing ST and RT and RR (Bianca, 1959; Murray, 1964; Yeates and Murray, 1966). It can be stated that cows with less heat stress would have more feed intake (Vajrabukka, 1978; Boonprong, 1999). However, the current results showed that clipped animals under field conditions can not improve any thermal balance in terms of RT, RR and SR, which would possibly not be expected to affect more pasture intake. Less minor grazing activity of the clipped cows and the adjustment of physiological responses should be considered for a variety of reasons for reduced pasture intake.

5. Blood Urea Nitrogen and Plasma Glucose

Animals in both groups had non-significant differences in BUN and plasma glucose before and after feeding. Both values were above the normal standard ranges of 12.3 to 17.8 mg/% for BUN (Rowlands *et al.*, 1977) and 42.7 mg% for plasma glucose (Payne *et al.*, 1974; Rowlands *et al.*, 1977). These results presumably indicated that cows in both treatments had a sufficient dietary ration for their requirements.

6. Milk Production

6.1 Milk yield

Under indoor feeding, significantly higher actual and FCM milk yields have previously been found in clipped cows relative to the unclipped cows due to a higher roughage intake (Boonprong, 1999). The current results found that there were non-significantly different actual milk and FCM yields in the clipped cows to the unclipped ones. Lower pasture intake would be expected to have a marked influence on these results and thermoregulatory responses under field conditions.

6.2 Milk composition

Under heat stress in the field, cows in both groups might have a greater opportunity to select more nutritious parts of the pasture plants available to them (Stobbs, 1975), particularly during night-time. As a result, milk composition in both groups was non-significantly different and also was under the normal standard ranges of milk composition (Larson, 1985).

7. Liveweight Changes

The observed trend for the cows to increase in LW as lactation advanced is consistent with earlier observations that cows partition more energy to body reserves than to milk production at that time (Bryant and Trigg, 1982; Chillard, 1989).

8. Physiological Responses

To some extent, the amount of solar heat which enters the body depends on the hair coat, which acts as the first line of defense (Bianca, 1976). The disadvantage of a long woolly coat in the high temperatures of tropical areas has generally been attributed to its interference with evaporation from the skin surface (Allen, 1962; Turner and Schleger, 1960). This is indirectly supported by the hot-room studies of Yeates (1955), Bianca (1959) and Vajrabukka (1978). In those studies, clipping woolly-coated animals caused a fall in RT and RR, which could not be attributed to increased non-evaporative heat loss. In a field experiment, however, Turner (1962) measured cutaneous evaporation from small clipped patches on unclipped and clipped Hereford calves and found no change in evaporative moisture loss associated with clipping. In Thailand, Boonprong (1999) found that clipped lactating cows when fully fed indoors, have highly significant decrease in SR, RT, and RR compared to unclipped controls, whose trends are similar to the results from Yeates (1955), Bianca (1959) and Vajrabukka (1978).

The current study indicated that mean coat score of animal before and after clipping were 2.83 and 2.0 units, respectively, which was classified as fairly short to very short (Turner and Schleger, 1960), indicating generally short-coated cows under tropical conditions (Bonsma, 1949). It would be expected to have a similar physiological responses when exposure to the sun. The current result showed that ST

was higher than RT in both groups of animals under field conditions which is similar to the result found in Prasanpanich *et al.* (2002). Since the animals in both groups were exposed to the sun from morning until afternoon times, the rising high ETs, solar radiation and RH (Tables 11 and 12) indicated a marked effect of solar radiation is known to be capable of not only of stimulating BT (Robertshaw, 1985) but also of initiating sweating (Murray, 1966; Ingram *et al.*, 1963; Amakiri and Onkuwa, 1980) to cool the skin (Klemm and Robinson, 1955). However, Berman and Kibler (1959) reported that clipping sometimes does not affect surface water loss due to the effect of humidity on sweating and insensible water loss. The significant and variable part of latent heat of vaporisation does not serve to cool the skin down. In addition, such high ET while increasing sweating also warms the skin and hair (Allen *et al.*, 1964). In fact, there might be some solar absorption on the black skin and a reflection in solar radiation to the white skin area (Hutchinson and Brown, 1969) whose amount of penetrant heat would be the sensible heat flow into the animal together with a high ET. The mean RH of 59% would be sufficient enough to certain restricted heat loss by evaporation (McDowell, 1972), resulting in the consistently high ST.

ET and solar radiation are known to have a marked influence on the grazed animals in terms of keeping their thermal stasis (McDowell, 1958; Finch, 1986). Clipping the fairly short-coated cows under field conditions resulted in a slight fall in RT and RR. This is in agreement with the findings of Price and Allen (1948), Murray (1966), Turner (1962) and Olson *et al.* (1992). The RT difference of 0.2°C is associated with a difference in SR presumably due to increased efficiency of heat exchange by cutaneous evaporative heat loss (Robertshaw, 1981) which becomes much greater than respiratory evaporation (McLean, 1963). In fact, the respiratory system appears to be the most flexible of the major sources by which the cow eliminates excess body heat, by adjusting its rate to that necessary to maintain normal temperature (Blight, 1957). In this way, the rapid onset of thermal polypnoea serves as a buffer mechanism which prevent any sudden rise in deep BT rather than an adjusting mechanism to counter such a change (Bright, 1957; Findlay, 1957; Bianca, 1959). However, excessive respiratory activity might cause panting, rapid shallow breathing followed by open-mouth breathing (Bianca, 1963), to occur during periods of idling activity among the grazed animals.

In addition, a slight difference of RR (2.5 breaths/min) between treatments was probably the result of increased skin sensitivity by sweating rather than simple facilitation of evaporation (Murray, 1966). The sensitivity of sweat glands located nearer to the skin surface (Dowling, 1958) are generally responded to the external stimuli more readily by removing the physical barrier of fairly short coat to expose to intensive solar radiation (Yeates, 1955; Bianca, 1959; Murray, 1966) which would be expected to have more SR in the clipped animals, however, the current result showed no significant difference in relation to the unclipped counterparts. In fact, the increase in RR and ST in the animals in both groups are a protective mechanism for the increased evaporative heat loss by respiratory passages and skin surface (Purwanto *et al.*, 1993). However, the large volume of sweat secreted is presumably evaporated efficiently to reduce ST in the clipped animals (Klemm and Robinson, 1955).

Ht and Hb contents of blood are known to decline during heat stress (Weldy *et al.*, 1964; Yousef and Johnson, 1965). All animals decreased both concentrations under field conditions which were below the normal standard ranges of 30% for Ht (Benjamin, 1978) and of 8-15 mg% for Hb contents (Horwitz, 1990) which were unlikely to have influenced energy metabolism or heat dissipation in these cows (Rousell *et al.*, 1970; Lee *et al.*, 1976). However, the clipped animals had slightly lower values may be a haemodilution effect whereby more water is transported in the circulatory system for evaporative cooling from the animal's surface (McDowell *et al.*, 1969; Joshi *et al.*, 1968). As a result, the clipped animals did show a higher SR. A reduction in oxygen transport in conjunction with a reduction in cellular metabolism is presumably involved in an attempt to reduce metabolic heat production (Yousef and Johnson, 1965; Rousell *et al.*, 1970) resulting in an additional reason for reduction in pasture intake.

Lower milk yield of the clipped animals under field conditions is associated with a decrease in feed intake, particularly pasture intake (Johnson, 1985). A reduction of pasture intake in the face of thermal stress under field conditions is a homeothermic mechanism (McDowell, 1972). Additionally, the decrease in feed intake then affects a decrease in gross efficiency of production not only through lower feed intake but also associated with an increase in energy requirement for maintenance (Kurihara *et al.*, 1990). The increase in energy requirement for maintenance may be closely involved with the increase in energy

requirement for extra thermoregulation (Purwanto *et al.*, 1992) in terms of radiation, convection and conduction. Since both evaporative and non-evaporative heat loss processes are expected to have a considerably influence on a homeothermic mechanism, it is probable that the shorter coat of the clipped animal, permits an alternative mean of heat loss by non-evaporative process in terms of radiation, convection and conduction (Bonsma and Pretorius, 1943; Allen *et al.*, 1963). These forms of thermoregulation require no physiological activity from the animals (Allen *et al.*, 1963), through their idling activity. As a result, an increase in energy cost for extra thermoregulation for the clipped animals under field conditions is associated with heat loss mechanism in both sensible and evaporative heat losses. If so, the clipped animals would presumably be more suffered to the environmental changes by which they need more time to adjust themselves.

Cortisol has a calorigenic effect in cattle (Yousef and Johnson, 1967). Low cortisol levels in the animals under field conditions are consistent with their heat acclimation as a beneficial thermoregulatory mechanism for reducing the level of heat production (Yousef and Johnson, 1967; Yousef, 1985b) by means of decreased their grazing during the day and increased nocturnal grazing activity, shown in Figure 2a. When determining T_3 and T_4 concentrations in cows between treatments, the non-significantly lower concentrations in the clipped cows would be associated with thermoregulatory mechanism for reducing the level of heat production via the hypothalamo-pituitary thyroid axis which was affected by elevated temperature and by lower pasture intake (Hurley *et al.*, 1980; Magdub *et al.*, 1982).

When calculating HTC, the clipped group seemed to have a slightly higher HTC due to their lower RT. More HTC the animal is, more heat tolerated the animal is (Rhoad, 1944). However, milk production and pasture intake were lower in the clipped animals than those in their unclipped counterparts. As mentioned above, the clipped animals have to respond to the radiant heat load to maintain their thermal balance under field conditions by both sensible and evaporative heat loss processes.

In conclusion, it is obvious that the clipping of animals that go out in the sun has been reported to increase the incidence of carcinomas and skin cancers in European-type animals that possess areas of unpigmented skin (Payne, 1955). The current study indicates that coat-clipped dairy

crossbred cows subjected to solar radiation under field conditions were at no advantage, compared to unclipped ones, in terms of both heat stress amelioration and dairy production.

LITERATURE CITED

- Albright, J.L. and C.W. Arave. 1997. *The Behaviour of Cattle*. CAB. International, Farnham Royal. 306 p.
- Allen, T.E. 1962. Responses of Zebu, Jersey and Zebu × Jersey crossbred heifers to rising temperature, with particular reference to sweating. *Aust. J. agric. Res.* 13 : 165-179.
- Allen, T.E., Y.S. Pan and R.H. Hayman. 1963. The effect of feeding on evaporative heat loss and body temperature in Zebu and Jersey heifers. *Aust. J. agric. Res.* 14 : 580-593.
- Allen, T.E., J.W. Bennett, S.W. Donegan and J.C.D. Hutchinson. 1964. Moisture in the coats of sweating cattle. *Proc. Aust. Soc. Anim. Prod.* 4 : 167-172.
- Amakiri, S.F. and S.K. Onkuwa. 1980. Quantitative studies of sweating rate in some cattle breeds in a humid tropical environment. *Anim. Prod.* 30 : 383-388.
- Armstrong, D.V. 1994. Heat stress interaction with shade and cooling. *J. Dairy Sci.* 77 : 2044-2050.
- Barlow, R., K.J. Ellis, P.J. Williamson, P. Costigan, P.D. Stephenson, G. Rose, and P.T. Mears. 1988. Dry matter intake of Hereford and first-cross cows measured by controlled release of chromic oxide on three pasture systems. *J. agric. Sci. (Camb.)* 110 : 217-231.
- Bennett, J.W. 1964. Thermal insulation of cattle coats. *Proc. Aust. Soc. Anim. Prod.* 5 : 160-166.
- Benjamin, M.M. 1978. *Outline of Veterinary Clinical Pathology*. 3rd ed, Iowa State University Press, Ames.

- Berman, A. and H.H. Kibler. 1959. Effect of clipping the coat on the thermoregulatory reactions of dairy heifers. *Nature (Lond.)* 180 : 606.
- Bianca, W. 1959. The effect of clipping the coat on various reactions of calves to heat. *J. agric. Sci. (Camb.)* 52 : 380-383.
- Bianca, W. 1963. Rectal temperature and respiratory rate as indicators of heat tolerance in cattle. *J. agric. Sci. (Camb.)* 60 : 113-120.
- Bianca, W. 1965. Reviews of the progress of dairy science. *J. Dairy Res.* 32 : 291-345.
- Bianca, W. 1968. Thermoregulation. pp. 97-118, *In* E. S. E. Hafez (ed.). *Adaptation of Domestic Animals*. Lea and Febiger, Philadelphia.
- Bianca, W. 1976. The significance of meteorology in animal production. *Int. J. Biometeor.* 20 : 139-156.
- Bilodeau, P.P., D. Petitclerc, N.ST. Pierre, G. Pelletier and G.J.ST. Laurent. 1989. *J. Dairy Sci.* 72 : 2999-3005.
- Blight, J. 1957. The initiation of thermal polypnea in the calf. *J. Physiol (Lond.)* 136 : 413-419.
- Blowey, R.W, D.W. Wood and J.R. Davies. 1973. A national monitoring system for dairy herds based on blood glucose, urea and albumin levels. *Vet. Rec.* 92 : 691-696.
- Bond, T.E. and C.F. Kelly. 1955. The globe thermometer in agricultural research. *Agric. Eng.* 36 : 251-258.
- Bond, T.E. and C.F. Kelly, S.R. Morrison and N. Pereira. 1967. Solar, atmospheric and terrestrial radiation received by shaded and unshaded animals. *Trans. Amer. Soc. Agric. Eng.* 10 : 622-627.
- Bonsma, J.C. 1949. Breeding cattle for increased adaptability to tropical and subtropical environments. *J. agric. Sci. (Camb.)* 39 : 204-220.
- Bonsma, J.C. and A.J. Pretorius. 1943. The influence of colour and coat cover on adaptation of cattle. *Fmg. S. Afr.* 18 : 101-104.

- Boonprong, S. 1999. Effect of coat type on certain physiological alterations and milk production performance in Australian Friesian-Sahiwal crossbred dairy cows. M.Sc. thesis, Kasetsart University, Bangkok.
- Bourne, R.A. and H.A. Tucker. 1975. Serum prolactin and LH responses to photoperiod in bull calves. *Endocrinology* 97 : 473-475.
- Bryan, W.W and J.P. Sharpe. 1965. The effects of urea and cutting treatments on the production of Pangola grass in south-eastern Queensland. *Aust. J. Exp. agric. Anim. Husb.* 5 : 433-441.
- Bryant, A.M. and T.E. Trigg. 1982. The nutrition of the grazing dairy cow in early lactation, pp. 213-125, *In* K.L. Macmillan and V.K. Taufa (eds.). *Dairy Production from Pasture*, New Zealand and Australian Societies of Animal Production, Hamilton.
- Buchanan, I.K., G. Arnold, G.W. Brown and M. Maroske. 1985. Effect of pasture slashing on milk production from summer grasses. *Qld. agric. J.* 111 : 41-44.
- Buxton, D.R. 1996. Quality-related characteristics of forages as influenced by plant environment and agronomic factors. *Anim. Feed Sci. Tech.* 59 : 37-49.
- Chilliard, Y. 1989. Physiological constraints to milk production: Factors which determine nutrient partitioning, lactation persistency and mobilisation of body reserves, pp. 22-35. *In* A. Speedy and R. Sansoucy (eds.), *Feeding Dairy Cows in the Tropics*. Proceedings of the FAO Expert Consultation, Bangkok.
- Christopherson, R.J. 1985. The thermal environment and the ruminant digestive system, pp. 145-158. *In* M.K. Yousef (ed.). *Stress Physiology in Livestock*, Vol. 1, Basic Principles, CRC Press Inc., Boca Raton.
- Corbett, J.L. 1978. Measuring animal performance, pp. 163-216. *In* L.'t Mannetje (ed.). *Measurement of Grassland Vegetation and Animal Production*. CAB International, Farnham Royal.

- Costigan, P. and K.J. Ellis. 1987. Analysis of faecal chromium derived from controlled release marker devices. *N.Z. J. Tech.* 3 : 89-92.
- Cowan, R.T. and T.M. Davison. 1983. The supplementation of dairy cows at pasture in Queensland, pp. 69-74. *In* D.J. Farrell and Pran Vohra (eds.). *Recent Advances in Animal Nutrition in Australia*, Armidale.
- Cowan, R.T., T.M. Davison and R.K. Shephard. 1986. Observations on the diet selection by Friesian cows grazing tropical grass and grass-legume pastures. *Trop. Grassl.* 20 : 183-191.
- Cowan, R.T., R.J. Moss and D.V. Kerr. 1993. Northern dairy feedbase 2001. 2. Summer feeding systems. *Trop. Grassl.* 27 : 150-161.
- Curtis, H.E. 1987. Light and mammalian reproduction, pp. 155-164. *In* H.E. Curtis (ed.). *Environmental Management in Animal Agriculture*. 2nd Printing, The Iowa State University Press, Ames.
- Dahl, G.E., L.T. Chapin, M.S. Allen, W.M. Moseley and H.A. Tucker. 1991. Comparison of somatotropin and growth hormone-releasing factor on milk yield, serum hormones and energy status. *J. Dairy Sci.* 74 : 3421-3431.
- Dahl, G.E., T.H. Elsasser, A.V. Capuco, R.A. Erdman and R.R. Peters. 1997. Effects of a long daily photoperiod on milk yield and circulating concentrations of Insulin-like Growth Factor-1. *J. Dairy Sci.* 80 : 2784-2789.
- Dahl, G.E., B.A. Buchanan and H.A. Tucker. 2000. Photoperiodic effects on dairy cattle: A Review. *J. Dairy Sci.* 83 : 885-893.
- Davison T.M. and R.T. Cowan. 1978. Effects of management on milk production from two tropical grasses. *Proc. Aust. Soc. Anim. Prod.* 12 : 231.
- Davison T.M., R.T. Cowan and P.K. O'Rourke. 1981. Management practices for tropical grasses and their effects on pasture and milk production. *Aust. J. Exp. agric. Anim. Husb.* 21 : 196-202.

- Davison T.M., B.A. Silver, A.T. Lisle and W.M. Orr. 1988. The influence of shade on milk production of Holstein-Friesian cows in a tropical upland environment. *Aust. J. Exp. agric.* 28 : 149-154
- Dowling, D.E. 1958. The significance of sweating in heat tolerance of cattle. *Aust. J. agric. Res.* 9 : 579-586.
- Elam, C.J. 1971. Problems related to intensive indoor beef production systems. *J. Anim. Sci.* 32 : 554-559.
- Evans, N.M. and R.R. Hacker. 1989. Effect of chronobiological manipulation of lactation in the dairy cow. *J Dairy Sci.* 72 : 2921-2927.
- Finch, V.A. 1986. Body temperature in beef cattle: its control and relevance to production in the tropics. *J. Anim. Sci.* 62 : 531-42
- Fuquay, J.W. 1981. Heat stress as it affects animal production. *J Anim. Sci.* 52 : 164-174.
- Gates, D.M. 1968. Physical environment, pp. 46-60. *In* E.S.E. Hafez (ed.). *Adaptation of Domestic Animals*. Lea & Febiger, Philadelphia
- Hafez, E.S.E. and M.F. Bouisson. 1975. The behaviour of cattle, pp. 203-244. *In* E.S.E. Hafez (ed.). *The Behaviour of Domestic Animals*. London: Bailliere Tindal.
- Hennessy, D.W. 1980. Protein nutrition of ruminants in the tropical areas of Australia. *Trop. Grassl.* 14 : 260-265
- Holmes, C.W. and G.F. Wilson. 1987. *Milk Production from Pasture* Butterworths Agricultural Books, Wellington. 319 p.
- Horwitz, H. 1990. *Methods of Analysis of Official Analytical Chemistry*. Association of Official Analytical Chemistry, Washington, D.C., 1018 p.
- Hoult, E.H. and P.M. Bryant 1974. Pasture sampling, pp. 232-240 *In* A Course Manual in Tropical Pasture Science Australian Vice-Chancellors' committee, Watson Ferguson & Co Ltd, Brisbane

- Hurley, W.L., E.M. Convey, K. Leung, L.A. Edgerton and R.W. Hemken. 1980. Bovine prolactin, TSH, T_4 and T_3 concentrations as affected by tall fescue summer toxicosis and temperature. *J. Anim. Sci.* 51 : 374-382.
- Hutchinson, J.C.D. and G.D. Brown. 1969. Penetrance of cattle coats by radiation. *J. Appl. Physiol.* 26 : 454-64.
- Hydrographic Department of Royal Thai Navy. 1998. A report on sunrise and sunset 1994-1998. Royal Thai Navy, Ministry of Defense, Bangkok, Thailand. 32 p.
- Ingram, D.L., J.A. McLean and G.C. Whittow. 1963. The effects of heating the hypothalamus and the skin on the rate of moisture vaporisation from the skin of the ox (*Bos taurus*). *J. Physiol. (Lond.)* 169 : 394-403.
- Johnson, H.D. 1985. Physiological responses and productivity of cattle, pp. 122-132. *In* M.K. Yousef (ed.). *Stress Physiology in Livestock*, Vol. 2 Ungulates, CRC Press, Inc., Boca Raton.
- Johnson, H.D., H.H. Kibler, A.C. Ragsdale, I.L. Berry and M.D. Shanklin. 1961. Role of heat tolerance and production level in responses of lactating Holsteins to various temperature-humidity conditions. *J. Dairy Sci.* 44 : 1191.
- Joshi, B.C., H.B. Joshi, R.E. McDowell and D.P. Sadhu. 1968. Composition of skin secretions from three Indian breeds of cattle under thermal stress. *J. Dairy Sci.* 51 : 917-920.
- Klemm, G.H. and Robinson, K.W. 1955. The heat tolerance of two breeds of calves from 1 to 12 months of age. *Aust. J. agric. Res.* 6 : 350-364.
- Kurihara, M., S. Kume, M. Shibata, S. Takahashi and T. Aii. 1990. The effect of environmental temperature on energy metabolism of dry dairy cows given hay at maintenance level. *Jpn. J. Zootech. Sci.* 61 : 315-321.

- Larson, B.L. 1985. Biosynthesis and cellular secretion of milk, pp. 129-162. *In* B.L. Larson (ed.). Lactation. The Iowa State University Press, Ames.
- Lee, J.A., J.D. Roussell and J.F. Beaty. 1976. Effect of temperature-season on bovine adrenal cortical function, blood cell profile and milk production. *J. Dairy Sci.* 59 : 104-114.
- Lefcourt, A.M. and E.T. Schmidtman. 1989. Body temperature of dry cows on pasture: Environmental and behavioural effects. *J. Dairy Sci.* 72 : 3040-3049.
- Leining, K.B., R.A. Bourne and H.A. Tucker. 1979. Prolactin response to duration and wavelength of light in prepubertal bulls. *Endocrinology* 104 : 289-294.
- Leng, R.A. 1984. Supplementation of tropical and sub-tropical pastures for ruminant production, pp. 129-144. *In* F.M.C. Gilchrist and R.I. Mackie (eds.). *Herbivore Nutrition in the Subtropics and Tropics*. The Science Press (Pty) Ltd., Craighall.
- Macfarlane, W. V. 1968. Adaption of ruminants to Tropics and Deserts, pp. 164-82. *In* E. S. E. Hafez (ed.). *Adaptation of Domestic Animals*, Lea & Febiger, Philadelphia.
- Magdub, A., H.D. Johnson and R.L. Belyea. 1982. Effect of environmental heat and dietary fiber on Thyroid physiology of lactating cows. *J. Dairy Sci.* 65 : 2323-2331.
- Martin P. and P. Bateson. 1986. *Measuring Behaviour: an introductory guide*. Cambridge Press, Washington, DC., 158p.
- McDowell, R.E. 1958. Physiological approaches to animal climatology. *J. Heredity* 2 : 52-61.
- McDowell, R.E. 1972. Determining the suitability of livestock to warm climates, pp. 133-155. *In* R.E. McDowell (ed.). *Improvement of Livestock Production in Warm Climates*. W.H. Freeman and Co., San Francisco.

- McDowell, R.E., E.G. Moody, P.J. van Soest, R.P. Lohmann and G.L. Ford. 1969. Effect of heat stress on energy and water utilization of lactating cows. *J. Dairy Sci.* 52 : 188-194.
- McDowell, R.E., N.W. Hooven and J.K. Camdens. 1976. Effect of climate on performance of Holsteins in first lactation. *J. Dairy Sci.* 59 : 965-973.
- McLean, J.A. 1963. The partition of insensible heat losses of body weight and heat from cattle under various climatic conditions. *J. Physiol. (Lond.)* 167 : 427-447.
- McLeod, M.N. and D.J. Minson. 1988. Large particle breakdown by cattle eating ryegrass and alfalfa. *J. Anim. Sci.* 66 : 992-999.
- Mercek, J.M. and L.V. Swanson. 1984. Effect of photoperiod on milk production and Prolactin of Holstein dairy cows. *J. Dairy Sci.* 67 : 2380-2388.
- Meteorological Department. 1998. Climatological Data of Thailand. Ministry of Communications, Bangkok. 15p.
- Miller, A.R.E., E.P. Stanisiewski, R.A. Erdman, L.W. Douglas, and G.E. Dahl. 1999. Effects of long daily photoperiod and bovine somatotropin (Trobect) on milk yield in cows. *J. Dairy Sci.* 82 : 1716-1722.
- Minson, D.J. 1982a. Effects of chemical and physiological composition of herbage eaten upon intake, pp. 167-182. *In* : J.B. Hacker (ed.). *Nutritional Limits to Animal Production from Pastures*. Commonwealth Agricultural Bureaux, Farnham Royal.
- Minson, D.J. 1982b. Effect of chemical composition on feed digestibility and metabolisable energy. *Nutr. Abstr. Rev. Series B.* 52 : 591-615.
- Murray, D. M. 1964. Coat shedding and sweating in cattle. M.Rur.Sc. Thesis, the University of New England, Armidale, NSW, Australia.

- Murray, D. M. 1966. A comparison of cutaneous evaporation rates in cattle exposed to heat in a climate laboratory and in the field. *J. agric. Sci. (Camb.)* 66 : 175-179.
- National Research Council. 1989. Nutrient Requirements of Dairy Cattle. 6th ed., National Academy Press, Washington, DC. 158 p.
- Nuttonson, M.Y. 1963. The Physical Environment and Agriculture of Thailand. American Institute of Crop Ecology, Washington, D.C.
- Olson, T.A., A.C. Hammond, L.J. Padgett, E.J. Bowers and E.L. Adams. 1992. Rectal temperature of Senapol (S), Hereford (H), S x H and H x S calves in a subtropical environment. *J. Anim. Sci.* 70 (Suppl. 1) : 160 .
- Payne, W.J.A. 1955. Some effects of improved management on dairy cattle in the tropics. *Anim. Breed. Abstr.* 23 : 1-14.
- Payne, J.M. and S. Payne. 1987. The Metabolic Profile Test. Oxford University Press, Oxford. 179 p.
- Payne, J.M., G.J. Rowland, R. Manston, S.M. Dew and W.H. Parker. 1974. A statistical appraisal of the results of the metabolic profile tests on 191 herds in B.V.A./A.D.A.S. joint exercise in animal health and reproductivity. *Brit. Vet. J.* 130 : 33-44.
- Peters, R.R. and H.A. Tucker. 1977. Prolactin and growth hormone response to photoperiod in heifers. *Endocrinology* 103 : 229-234.
- Peters, R.R., L.T. Chapin, K.B. Leining and H.A. Tucker. 1978. Supplemental lighting stimulates growth and lactation in cattle. *Science* 99 : 911-912.
- Peters, R.R., L.T. Chapin, R.S. Emery and H.A. Tucker. 1981. Milk yield, feed intake, prolactin, growth hormone and glucocorticoid response of cows to supplemental light. *J. Dairy Sci.* 64 : 1671-1684.
- Phillips, C.J.C. and S.A. Schofield. 1989. The effects of supplementary light on the production and behaviour of dairy cows. *Anim. Prod.* 48 : 293-303.

- Piva, G., P. Navarotto, G. Fusconi and S. Repetti. 1992. Effect of photoperiod on milk production and composition of dairy cows. *J. Anim. Sci.* 70 (Suppl. 1) : 165.
- Prasanpanich, S. 2001. Climatic effects on dairy production in the central part of Thailand. Ph.D. thesis. Kasetsart University, Bangkok, Thailand.
- Prasanpanich, S., P. Sukpitaksakul, S. Tudsri, and C. Vajrabukka. 2000. Comparison on eating patterns of lactating cows fed indoor and on grazing pasture during hot-humid months in Central Thailand. *Asian-Aus. J. Anim. Sci.* 13 Supplement July 2000 : 224.
- Price, R.B., Jr. and N.N. Allen. 1948. Some physiological effects of clipping dairy cows. *J. Anim. Sci.* 7 : 543-544 (Abstr.).
- Purwanto, B.P., M. Fujita, M. Nishibori and S. Yamamoto. 1992. Effect of environmental temperature and feed intake on plasma concentration of Thyroid hormones in dairy heifers. *Asian-Aust. J. Anim. Sci.* 4 : 293-298.
- Purwanto, B.P., F. Nakamasu and S. Yamamoto. 1993. Relationship between heat production and respiratory rate in dairy heifers: Effects of short exposure, pp. 427-428. *In* Proceedings of the World Conference on Animal Production. Vol. 2, Edmonton.
- Ree, M.C., D.J. Minson and J.D. Kerr. 1972. Relationship of dairy productivity to feed supply in the Gympie district of south-eastern Queensland. *Aust. J. Exp. agric. Anim. Husb.* 12 : 553-560.
- Reksen, O., A. Tverdal, K. Landsverk, E. Kommisrud, K.E. Bøe and E. Rodstad. 1999. Effects of photointensity and photoperiod on milk yield and reproductive performance of Norwegian Red Cattle. *J. Dairy Sci.* 82 : 810-816.
- Rhoad, A.O. 1944. The Iberia heat tolerance test for cattle. *Trop. agric.* 21 : 162-164.

- Rhynes, W.E. and L.L. Ewing. 1973. Plasma corticoids in Hereford bulls exposed to high ambient temperature. *J. Anim. Sci.* 36 : 369-373.
- Riek, R.F. and D.H.K. Lee. 1948. Reaction to hot atmosphere of Jersey cows in milk. *J. Dairy Res.* 15 : 219-226.
- Robertshaw, D. 1981. The enviromental physiology of animal production, pp. 3-17. *In* J.A. Clark (ed.). *Environmental Aspects of Housing for Animal Production.*, Butterworths, London.
- Robertshaw, D. 1985. Heat loss of cattle, pp. 55-66. *In* M.K. Yousef. (ed.). *Stress Physiology in Livestock.* Vol. 1, CRC Press, Inc., Boca Raton.
- Rook, J.A.F. and R.C. Campling. 1965. Effect of stage of lactation on the yield and composition of cows' milk. *J. Dairy Res.* 32 : 45-52.
- Roussel, J.D., T.E. Patrick, H.C. Kellgren, J.F. Beaty, A. Cousar and J.A. Lee. 1970. Temperature effect of blood cells, enzymes and protein activity of beef bulls. *J. Anim. Sci.* 30 : 327-339.
- Rowlands, G.J., W. Little and B.A. Kitchenham. 1977. Relationships between composition and fertility in dairy cows – a field study. *J. Dairy Res.* 44 : 1-7.
- SAS. 1985. *Statistical Analysis System.* SAS Institute Inc., North Carolina. 506 p.
- Schleger, A. V. and T.G. Turner. 1965. Sweating rates of cattle in the field and their reaction to diurnal and seasonal changes. *Aust. J. agric. Res.* 16 : 92-106.
- Shearer, J.K. and D.K. Beede. 1990. Effects of high environmental temperature on production and health of dairy cattle. *Agri-Practice*, September/October, 1990. 11 : 23-30.
- Slein, M.W. 1963. *Methods of Enzymatic Analysis.* Acedemic Press, New York.

- Stanisiewski, E.P., R.W. Mellenberger, C.R. Anderson and H.A. Tucker. 1985. Effect of photoperiod on milk yield and milk fat in commercial dairy herds. *J. Dairy Sci.* 68 : 1134-1141.
- Stobbs, T.H. 1971. Quality of pasture and forage crops for dairy production in the tropical regions of Australia. 1. Review of the literature. *Trop. Grassl.* 5 : 159-166.
- Stobbs, T.H. 1975. Factors limiting the nutritional value of grazed tropical pastures for beef and milk production. *Trop. Grassl.* 9 : 141-150.
- Sweeney, F.C. and J.M. Hopkinson. 1975. Vegetative growth of nineteen tropical and subtropical pasture grasses and legumes in relative to temperature. *Trop. Grassl.* 9 : 205-217.
- Tanida, H.L., L.V. Swanson and W.D. Hohenboken. 1984. Effect of artificial photoperiod on eating behaviours and other behavioural observations of dairy cows. *J. Dairy Sci.* 67 : 585-594.
- Thompson, N.A. 1986. Techniques available for assessing pasture. *Dairyfarming Annual Meeting.* pp. 113-121.
- Tiffany, T.O, J.M. Jansen, C.A. Burtis, J.B. Overton and C.D. Scott. 1972. Enzymatic kinetic rate and end point analyses of substrate by the use of a GeMSAEC fast analyser. *Clin. Chem.* 18 : 829-840.
- Tilley, J.M.A. and R.A. Terry. 1963. A two stage technique for in vitro of forage crops. *J. Brit. Grassl. Soc.* 18 : 104-111.
- Tucker, H.A. 1994. Lactation and its hormonal control, pp. 1065-1098. *In* E. Knobil and J.D. Neill (eds.). *The Physiology of Reproduction*, Vol. 2, Raven Press, New York.
- Tucker, H.A. 2000. Hormones, mammary growth and lactation: a 41-year perspective. *J. Dairy Sci.* 83 : 874-884.
- Turner, H.G. 1962. The effect of clipping the coat on performance of calves in the field. *Aust. J. agric. Res.* 13 : 180-192.

- Turner, H.G. and A.V. Schleger. 1960. The significance of coat type in cattle. *Aust. J. agric. Res.* 11 : 645-663.
- van Soest, P.J. 1967. Development of a comparative system of feed analyses and its application to forages. *J. Dairy Sci.* 26 : 119-128.
- Vajrabukka, C. 1978. Seasonal changes in the hair and coat characteristics of Hereford cattle, with observations on the association between coat character and heat tolerance at various temperatures and humidities. M.Ag.Sc. thesis, University of New England, Armidale, Australia.
- Walker, R.G., R.T. Cowan, W.N. Orr and B.A. Silver. 1996. Effect of access to irrigated ryegrass on the milk yield and composition of autumn calving cows in a tropical upland environment. *Trop. Grassl.* 30 : 249-256.
- Walker, G.P., C.R. Stockdale, W.J. Wales, P.T. Doyle and D.W. Dellow. 2001. Effect of level of grain supplementation on milk production responses of dairy cows in mid-late lactation when grazing irrigated pastures high in paspalum (*Paspalum dilatatum* Poir.). 41 : 1-11.
- Webb, F.M., V. F. Colenbrander, T.H. Blosser and D.E. Waldem. 1963. Eating habits of dairy cows under drylot conditions. *J. Dairy Sci.* 46 : 1433-1435.
- Weldy, J.R., R.E. McDowell, P.J. van Soest and J. Bond. 1964. Influence of heat stress on rumen acid levels and some blood constituents in cattle. *J. Anim. Sci.* 23 : 147-153.
- Wetteman, R.P. and H.A. Tucker. 1974. Relationship of ambient temperature to serum prolactin in heifers. *Proc. Soc. Exp. Biol. Med.* 146 : 908-911.
- Whiteman, P.C. 1980. *Tropical Pasture Science*. Oxford University Press, Oxford.
- Winter, P., J.H. Weniger and J.E. Huhn. 1980. Studies of the grazing behaviour of Taurine and Zebuine cattle in Bangladesh. *Anim. Res. and Dev.* 12 : 26-77.

- Yeates, N.T.M. 1955. Photoperiodicity in cattle. I. Seasonal changes in coat character and their importance in heat regulation. Aust. J. agric. Res. 6 : 891-902.
- Yeates, N.T.M. and D.M. Murray. 1966. Walking trials with cattle. 1. A breed comparison in moderate heat. J. agric. Sci. (Camb.) 66 : 353-358.
- Yousef, M.K. 1985a. Thermo-neutral zone, pp. 9-14. *In* M.K. Yousef (ed.). Stress Physiology in Livestock, Vol. 1 Basic Principles, CRC Press, Inc., Boca Raton.
- Yousef, M.K. 1985b. Measurement of heat production and heat loss, pp. 35-44. *In* M.K. Yousef (ed.). Stress Physiology in Livestock, Vol. 1, CRC Press, Inc., Boca Raton.
- Yousef, M.K. and H.D. Johnson. 1965. Some blood constituents of dairy cattle: influence of thyroxine and high environmental temperature. J. Dairy Sci. 48 : 1074-1080.
- Yousef, M.K. and H.D. Johnson. 1967. Calorigenesis of cattle as influenced by hydrocortisone and environmental temperature. J. Anim. Sci. 26 : 1087-1094.
- Yousef, M.K. and H.D. Johnson. 1985. Endocrine system and thermal environment, pp. 133-142. *In* M.K. Yousef (ed.). Stress Physiology in Livestock, Vol 1. Basic Principles, CRC Press, Inc., Boca Raton.

PROJECT OUTCOME

There is an interesting data on milk production from crossbred lactating cows exposed to the supplemental lighting as long day photoperiod of 16 hours daily. The current results reported an increase in milk yield in association with higher feed intake and elevated concentration of circulating IGF-1. Than, it can be expressed that there is a possibility of long photoperiod on dairy performance. However, more research works on stage of lactation, number of cows and also on photoperiodic effect on either reproduction or changes in neuro-endocrinological hormones are needed to support the current findings under tropical conditions as well as an economic response from such management.

Coat clipping is known to cause a decline in physiological responses and increase milk yield of lactating cows under indoor feeding conditions. However, under outdoor conditions as in grazing pasture, there were at no advantage compared to the unclipped cows, in terms of both heat stress amelioration and milk production.

A general outcome drawn from this study is to focus on the appropriate management for dairy farmers to improve their farm management in accordance with better physiological changes of animals to the tropical environment.