UNIVERSIDAD AUTÓNOMA AGRARIA ANTONIO NARRO

DIVISIÓN DE CIENCIA ANIMAL

DEPARTAMENTO DE NUTRICIÓN ANIMAL

EFFECTS OF HEAT STRESS ON GROWTH RATE OF HOLSTEIN CALVES BEFORE AND AFTER BIRTH IN A HOT-ARID ENVIRONMENT

POR:

ANGEL MARIO MARTINEZ RODRIGUEZ

TESIS

PRESENTADA COMO REQUISITO PARCIAL PARA OBTENER EL TÍTULO DE:

INGENIERO AGRÓNOMO ZOOTECNISTA

SALTILLO, COAHUILA, MÉXICO.

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Dedicatory

To my family:

Manuela Rodríguez Hernández, my mom, Mario Martínez Correa, my dad and Cesar Alejandro Martínez Rodríguez, my bro. You are my will, my force and my inspiration to do impossible things.

Acknowledgements

Thanks to my dad, the provider and my inspiration. Without him, nothing would have been possible through the duration of my studies, and also I want to thank to my mom. My guide, my guru, and my best friend. Thanks for her understanding and endless love. And for my brother, “be great, ‘cause I wanna be like you or even greater” he said to me.

Also I want to thank to my teachers, Álvaro Rodríguez Rivera, Miguel Mellado Bosque, Eduardo Garcia Martinez, and Manuela Bolivar Duarte. Thanks for their unconditional support and especially thanks to professor Alvaro who guided me since the beginning of my studies and led me to right people.

Not forgetting my friends, “los gordos” and my friend Norix Lo’. They made me smile when things seemed to be blurred, I enjoyed every time I spent with them

Finally, I want to gift my gratitude to Alfonso Nava. This research project would not have been possible without the support of him and “Puerto Chico, Lanchares S.A. de C.V.” part of “Grupo Tricio-Haro”.

CONTENT

ABSTRACT

Five Thousand Nine hundred thirty eight Holstein calves from 3 large commercial dairy herds in northern Mexico (26º N; 24.2°C mean annual temperature) were used to assessed the association between growth traits (birth body weight, weaning weight, daily weight gain) and climate variables indicative of heat stress (e.g. maximum ambient temperature, Maxt, temperature-humidity index, THI) before and after calving until weaning. The effect of season, Maxt and THI the day of calving and Maxt one and two months prior to calving were analyzed by the GLM procedure of SAS. When temperature and THI reached 34°C and 80 units birth body weight (bBW) had a sharp drop ($P<0.01$) compared with lower temperatures. bBW was lower ($P<0.01$) in calves born in Spring than the rest of the year (37.52 ± vs 38.53 ± kg; mean ± SD). Maxt one or two months before calving did not affect bBW. Weaning body weight (wBW) and daily weight gain (DWG) of calves decreased gradually ($P<0.01$) when Maxt and THI reached 28°C and 73 units, respectively. A season effect was detected ($P<0.01$) for wBW. These traits were 0.458 and 0.411 kg per d and 68.11 and 64.8kg in winter and summer, respectively. A High correlation was found between wBW and Maxt one and two month before calving. The same occurred with DWG. More studies are needed for a possible carry-over effect with the high heat loads with these variables. It was concluded that in this particular environment (high heat load for the most part of the year), heat stress markedly affect birth weight and growth rate of Holstein calves.

Key Words: Holsteins Calves, heat stress, grow traits, birth body weight, weaning weight, daily weight gain, Temperature Humidity Index,

RESUMEN

5938 becerros Holstein de 3 grandes establos lecheros en el Torreon, Coahuila México (26º N; con temperatura media anual de 24.2°C) fueron usados para evaluar la relación entre el crecimiento (peso al nacimiento, peso al destete y ganancia daría de peso) y las variables que indican estrés calórico. (Ej. Temperatura Máxima, Maxt, Índice Temperatura-Humedad THI) antes y después del nacimiento hasta el destete. El efecto causado por la estación, Maxt y THI el día del nacimiento y Maxt uno y dos meses antes del nacimiento fueron evaluados por el procedimiento GLM de SAS. Cuando la temperatura y el THI alcanzan 34°C y 80 unidades de THI, los pesos al nacimiento (bBW) de los becerros bajan estrepitosamente (P<0.01), comparando cuanto nacen con temperaturas mas bajas. Los pesos mas bajos (P<0.01) se presentan en la primavera (37.52 ± vs 38.53 ± kg; mean ± SD). Las máximas temperaturas dos y un mes antes del nacimiento no afectan los pesos al nacimiento. Los pesos al destete (wBW) y la ganancia diaria de peso (DWG) de los becerros disminuyen gradualmente (P<0.01) cuando Maxt y THI alcanzan 28°C y 73 unidades, respectivamente. Un efecto estacional se detecta (P<0.01) para DWG y wBW. Estos tratamientos son 0.458 y 0.411kg por día y 68.11 y 64.8 kg respectivamente. Una alta correlación fue encontrada entre bBW y uno y dos meses antes del nacimiento. Lo mismo ocurre con DWG. Más estudios son necesarios para evaluar un posible efecto traumático del crecimiento de los becerros expuestos a

grandes cargas de calor meses antes de nacer. Se concluyo que en este particular ambiente (con cargas calóricas la mayor parte del año), el estrés calórico afecta, marcadamente a los pesos al nacimiento y la tasa de crecimiento de los becerros Holstein

Palabras Clave: Becerros Holstein, estrés calórico, rasgos de crecimiento, peso al nacimiento, peso al destete, ganancia diaria de peso, índice de temperatura y humedad.

INTRODUCTION

In the dairy industry, heat-stress has caused an average loss of nearly $ 897 million annually in the United States (St-Pierre et al., 2003), especially in Texas, California, Oklahoma, Nebraska and North Carolina, due to the fact that heat stress decreases animal performance and increases mortality during the warm season.

Improving our knowledge on physiological and metabolic mechanisms of acclimation may contribute to the development and adoption of procedures (genetic, managerial and nutritional) that may help to maintain health, reproductive and productive efficiency in high-yielding dairy cows living in hot environments.

Heat stress can be defined as a physiological condition when the core body temperature of a given species exceeds its range specified for normal activity, which results from a total heat load (internal production and environment) exceeding the capacity for heat dissipation; this prompts physiological and behavioral responses to reduce the strain (Bernabucci et al., 2010). The ability of ruminants to regulate body temperature is species- and breed-dependent.

Holstein cows are capable of maintain a stable body temperature in certain temperatures (Kadzere et al., 2002). Thermal regulatory physiology of the cow may have changed in response to genetic selection for increases milk production.

Heat tolerance is a complex phenomenon. Its study involves three factors: the thermal environment, the animal body and a suitable scale for expressing numerically the effect of the thermal environment on the animal body (Bianca, 1961).

Acclimation is the animal response to heat loads and involves an altered expression of pre-existing features and is a process driven by the endocrine system, which could be divide in phases, first one is known as short-term heat acclimation (STHA) (Horowitz et al., 1996), and the second one is the large-term heat acclimation (LTHA) (Maloyan and Horowitz, 2002). The differences are that STHA is the phase which cellular signals pathways are changed initially and the LTHA is characterized by a reprogrammed gene expression and cellular response resulting in enhanced efficiency of signaling pathways and metabolic processes.

These processes involve, firstly, at couple hours later, a decreased dry matter intake (ad libitum cow dry matter intake by 35%; Rhoads et al., 2009) when THI reaches 68, consequently, milk yields decreases significantly (Zimbelman et al., 2009). Also, it other responses to heat stress are the increase of respiration rate, and rectal and skin temperature (Kadzere et al., 2002).

The highest milk production in Holstein cows under a desert environment (Arizona) is reached below 21°C throughout the day (Igono et al., 1992). Cows studied were affected by heat loads in a prolonged periods of time (Dikmen et al., 2012). Under these circumstances animals stop ruminating, increases respiration rate and consequently panting is more frequent.

If exposure to the thermal load is prolonged, heat acclimation is achieved via a processes of acclamatory homeostasis (Maloyan and Horowitz, 2002), and these are partially characterized by a decrease in growth hormone (GH), catecholamine and glucocorticoid levels. This altered endocrine status acts to lower circulating levels of thyroxine (T4) and triiodothyronine (T3) (Collier et al., 1982), and this reduces the basal metabolic rate and thus heat production.

Bovine skeletal muscle may experience mitochondrial dysfunction leading to impair cellular energy status. Therefore, it could be expected a reduced growth rate and decreased milk production, due to skeletal muscle is not able to make necessary contributions to whole-body energy (Bernabucci et al., 2010).

It is well-studied that reproduction as well as nutrition, is highly affected by heat stress. Season and lower latitudes can also have an effect in conception rate (Nagamine and Sasaki, 2008), due to increased heat loads. in Mexico, The differences of conception rate due to season could be determine, in summer is 32% and winter 36% ($P<0.01$) (Villa-Mancera et al., 2011; Mellado et al., 2013).

Activity and other manifestation of oestrus were also reduced and the incidence of anoestrus and silent ovulation were increased (Rensis and Scaramuzzi, 2003).

In spite of various studies, there is no sufficient analysis that could make certain that calves are affected by heat stress in the same way as adult cows are, even in the mother's womb.

In certain studies it was inferred that heat stress could cause low birth weights due to a prolonged exposure during pregnancy. Calves from cows with controlled climate had greater BW than calves from heat stressed cow at birth (42.5 vs 36 kg) (Tao et al., 2012) as well as weaning body weight (78.5 vs 65.9 kg).

Seasonal factors also significantly influenced the rate of gain and concentrations of serum Ig from birth to 180 d in another study (Robison et al., 1988)

Ewes with heat stress showed a reduced fetal development and low placental weight (Galan et al., 2005). Feed intake dry matter decreased by 25% in heat stressed animals and also placental weight was reduced 54% ($P<0.001$) compared with normal conditions. Besides, placenta weight was correlated positively with fetal weight and correlated negatively with fetal placental weight ratio (Bell et al., 1989). Heat stress caused chronic changes in plasma concentration of estrogene sulfate concentration.

It is known that fetal growth was restricted by placental size in heat-stressed-ewes. This is a primary effect of chronic maternal heat stress (Bell et al., 1987). Uterine and umbilical blood flows and placental glucose transfer capacity were all significantly reduced. It is associated with retardation of fetal growth and represents a fetal adaptation to a decreased placental ability to supply oxygen and nutrients (Thureen et al., 1992).

Cows with shade gave birth to calves with greater body weight than cows with no shade and also have better concentration of plasma estrogen sulfate (Collier et al., 1982).

Calf birth weight was positively correlated with maternal plasma estrogen sulfate concentration and also with total placenta weight (Echternkamp, 1993).

Calves were exposed to heat loads (40°C H 30%) (Singh and Newton, 1978a) in an arid climate. Their respiratory rate, skin temperature and rectal temperature rose sharply the 1st day but then gradually decline with a daily continued exposure, young calves have a well-developed ability of acclimation to high ambient temperatures.

Furthermore, the heart rate declined with successive days of exposure. A gradual increase in sweating rates of calves was observed; moreover, there is an increase of serum potassium and nitrogen in sweat (Singh and Newton, 1978b). Given that most studies on the effect of heat stress on dairy cows have been conducted in latitudes >30°N and that these studies have been focused on milk yield and reproductive efficiency, it was considered pertinent to explore the effect of heat stress on growth traits of Holstein calves in northern Mexico.

The purpose of this study is to explore and confirm that the growth rate of calves is affected by climatic factors such as maximum ambient temperature and the Temperature-Humidity index, before and after calving. In addition, it was assessed what months of birth affected the most the growth traits of dairy calves.

We hypothesized that heat-stressed-dams gave birth to calves with lower weights than thermo-neutral-dams (Tao et al., 2012) and that high temperatures experienced by the dam one and two months before calving could affect the growth of fetus due to the changes of maternal hormones (Collier et al., 1982) and lower blood pressure (Bell et al., 1989) during the last trimester of pregnancy. Moreover, calves born in summer months are highly affected in their body development and reach lower weaning weights than calves born in winter months.

MATERIALS AND METHODS

Animal and management

In this study, 5,938 Holstein calves from three dairy farms located in northern Mexico (25.9°N) were used. Calves were born between April 12, 2008 and August 19, 2012. Calves were followed from birth to Weaning. Pre-weaning stage lasts 60 d on average.

Calves were housed in individual cages (2 x 1.5 m) made with iron bars arranged horizontally; in consequence, the places where the calves were raised were well-ventilated. Each cage had a metal roofing sheet and a double bucket holder for 4 liters bucket, bedding was not available. The zone of the calves was surrounded by a barrier of trees (*Acacia farnesiana*) separated about 2 meters from each other in order to avoid cold airflows, additionally, these wind barriers had an extra-shade made with shadow mesh . The floor was a layer of 15 cm of sand. Cages were about 1 meter apart from one another.

All calves received 1 L of colostrum in the first 2 hours after birth and another one 3 hours later. Thereafter, milk replacer (about 20% crude protein) was fed twice daily, and calves were offered 2 L in buckets at each feeding during the first 30 d of age, and then once a day until 60 d of age, when calves were weaned.

Moreover, calves were fed a balanced diet (20 to 22% CP), and 4 liters of previously filtered groundwater. Grain was fed once a day in the morning moderately (just a half of the bucket), during the first 60 d of age. Cows were separated 3 weeks before calving, and parturition took place in pens exclusive for pregnant animals.

To assess the impact of heat-stress on animal growth traits, growth variables were recorded. Birth weights (bBW) were obtained prior to colostrum was fed and weaning weights (wBw) were obtained approximately 60 d after the calves were born. The scale used for the study was mechanical with a capacity of 200 kg. Daily weight gain (DWG) was obtained with the difference between bBW and wBW divided by the number of days of pre-weaning stage.

Meteorological records were obtained from a meteorological station (763820 MMTC) located 44 to 66 km away from the dairy operations for the duration of the study. This information included daily maximum air temperatures (maxt), average relative humidity the day of calving (H), this information was used to calculate the THI for each day, using the following equation THI=0.81 maxt+0.01 H (0.99 T−14.3)+46.3, where maxt=maximum air temperature (°C), and H=relative humidity (%) (Hahn, 1997); highest ambient daily temperature was in Celsius degrees):

In addition, maximum monthly averages of one and two month prior to birth were used in the analyses.

Statistical Analyses

Non-lineal regression analyses were used to assess the relationship between growth traits and climatic variables. These models were chosen considering the best goodness of fit indicated by the CurveExpert Proffesional® program (version 1.6).

Climatic variables were divided into classes, and separated in ranges of certain units to determine values which could have an effect in animal condition due to heat stress:

THI values were divided into 7 classes, first class was <70 and last class was >84; set at each three units intervals.

Maxt values were divided into 7 classes, first class was <25° C and last class was >40°C; all other classes were set at each three units interval.

1mb and 2mb values were divided into 6 classes, first class was <24°C and last class was >36; all other classes were set at three unit interval.

The GLM procedure of SAS (SAS Institute, Inc., Cary, NC, USA, 2009) was used to compare variables indicative of thermal stress at calves. The LSM procedure was used to assess the differences among all means. Letters that are the same in graphics did not displayed significant differences. These were considered to be significant at $P<0.05$, unless otherwise indicated.

RESULTS AND DISCUSSION

Differences were found with other researchers regarding the effect of heat load on growth traits of calves. Overall, birth weights in the present study were < 40 kg, which are lower compared with many other studies with Holstein calves in temperate zones (Tao et al., 2012; Wolfenson et al., 1988). This response may be due to extreme heat loads which are more prolonged at this latitude (26°N). According with Al-Shorepy and Notter (1998), negative effects on birth weight have been reported for lambs gestated during summer in equatorial and subtropical regions. Thus, low latitude had a negative impact in bBW in Holstein calves. In addition, bBW remained steady until 34°C the day of birth (Fig.1); likewise, when THI reached 80-83 units birth weight sharply declined (Fig. 2). Therefore, bBW had a sharp decrease, influenced by heat load during the day of their birth.

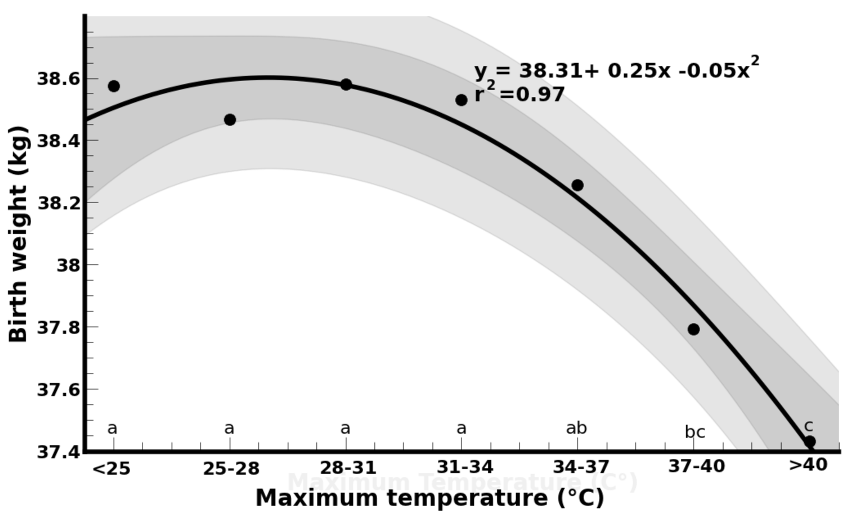

Fig. 1. The effect of ambient temperature the day of birth on birth weight of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within temperature ranges, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

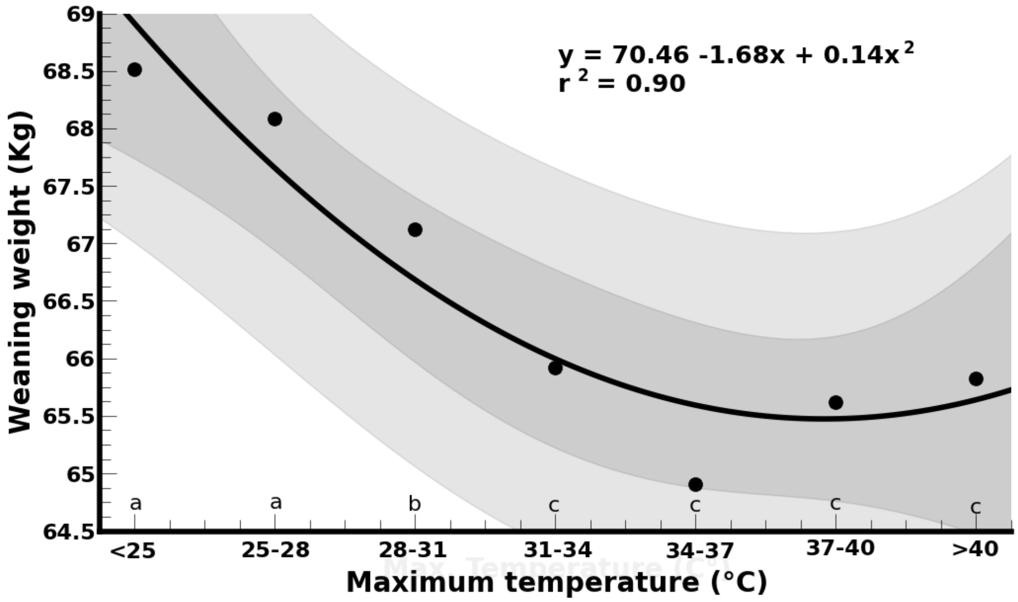

Fig. 2. The effect of temperature-humidity-index (THI) the day of birth on birth weight of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within THI, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

The months where the calves presented the lowest bBW were May and April, thereafter none of these months displayed a real significant differences with all other months. This phenomenon is due to the beginning of extreme heat loads and also precipitation does not occur in these months. (Fig. 3)

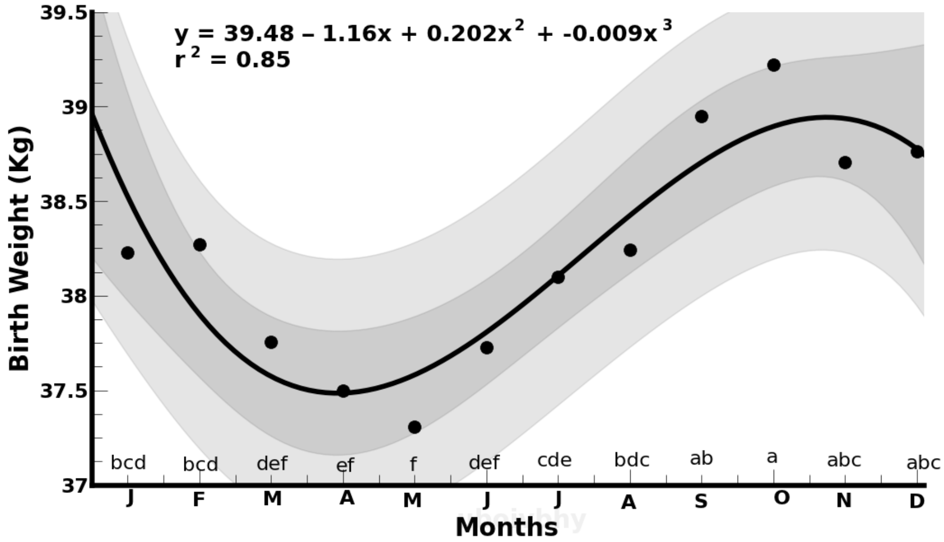

Fig. 3.The effect of month of calving on birth weight of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within months, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

Ambient temperatures one (Fig. 4) and two (Fig. 5) months before calving did not alter bBW of calves, which is contrary with other authors (Wolfenson et al., 1988), who demonstrated a clear correlations between the increase in ambient temperature and birth weights, which means that changes in fetal growth rate in Holsteins cows occurs, probably, in less than a one month period. More studies will be necessary to assess the decrease of fetal growth rate in Holstein calves during the last month of pregnancy

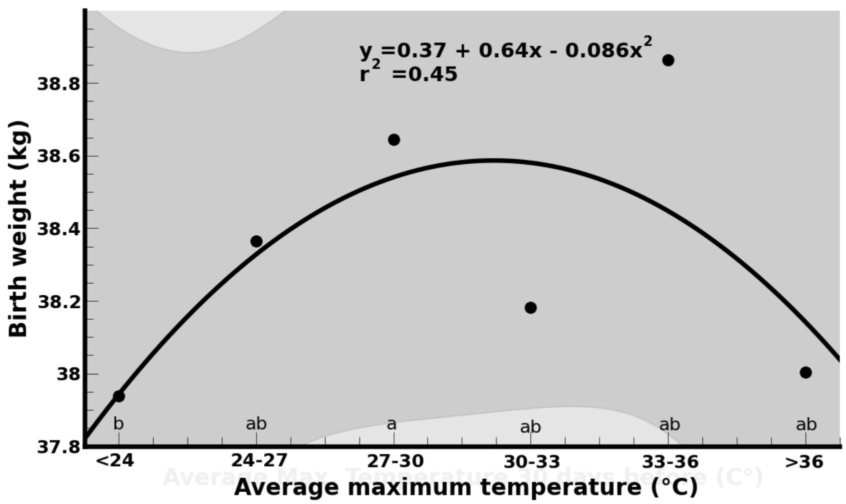

Fig. 4.The effect of maximum ambient temperature one month before calving on birth weight of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within temperature ranges, dissimilar letters differ ($P<0.01$). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

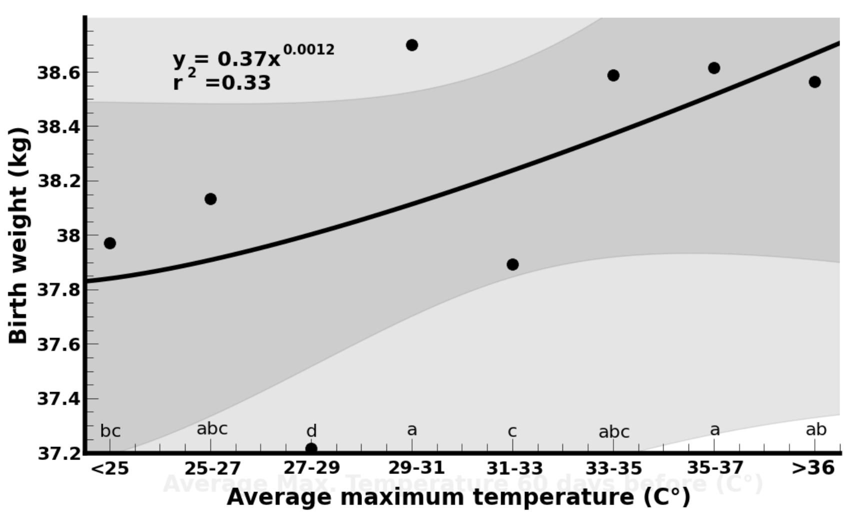

Fig. 5. The effect of temperature two months before, on birth weight of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within temperature ranges, dissimilar letters differ ($P<0.01$). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

Comparing with other farm species, ewes have automatic responses to heat stress. They reduce placental weight (Thureen et al., 1992; Ross et al., 1996), uterine blood flow (Fowden et al., 2010) vascular endothelial growth factor (Regnault et al., 2002) and gravid uterine and umbilical glucose uptakes (Bell et al., 1989). In consequence, there is a decrease of growth rate of fetuses. Similarly, *Bos indicus* breeds had adaptations for mitigating prolonged heat loads in tropical environments (Bernabucci et al., 2010). As a result, *Bos indicus* cattle produce calves with lower birth weights than *Bos taurus* cows.

Thus, the aforementioned information confirm the low capacity of Holstein cattle to response to hot environments, and prolonged heat loads in pregnancy stage, in contrast with other breeds of cattle, which are more adapted to this climate, which could increase the incidence of abortions (Pegorer et al., 2007) and retained placenta related to the occurrence of dystocia (DuBois and Williams, 1980) caused by greater bBW.

On the other hand, wBW (Fig. 6 and 7) and DWG (Fig. 8 and 9) followed a negative correlation with climate variables. Thus, it was clear that Holstein calves are equally sensitive to heat stress as are adult cow, apparently due to a decreased dry matter intake (West, 2003). In the present study, there was a fall of weights when Maxt and THI reached 28-31°C and 73-76 units, respectively, and these tendencies were described by exponential models.

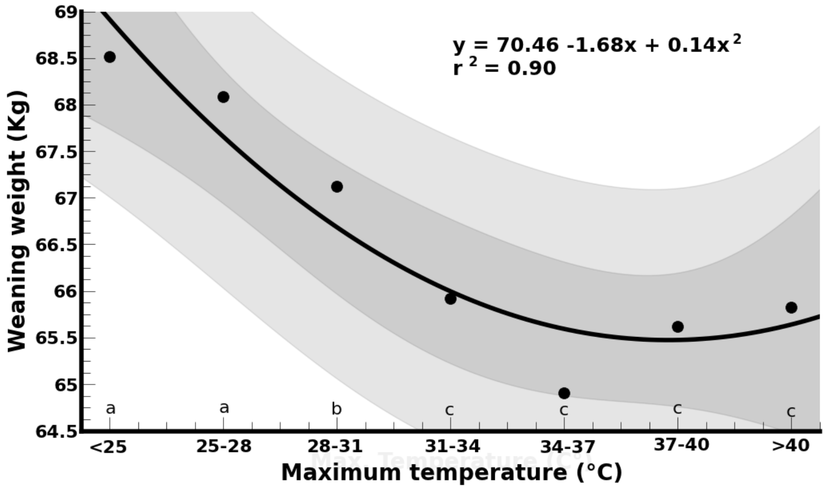

Fig. 6. The effect of maximum ambient temperature the day of birth on weaning weight of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within temperature ranges, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

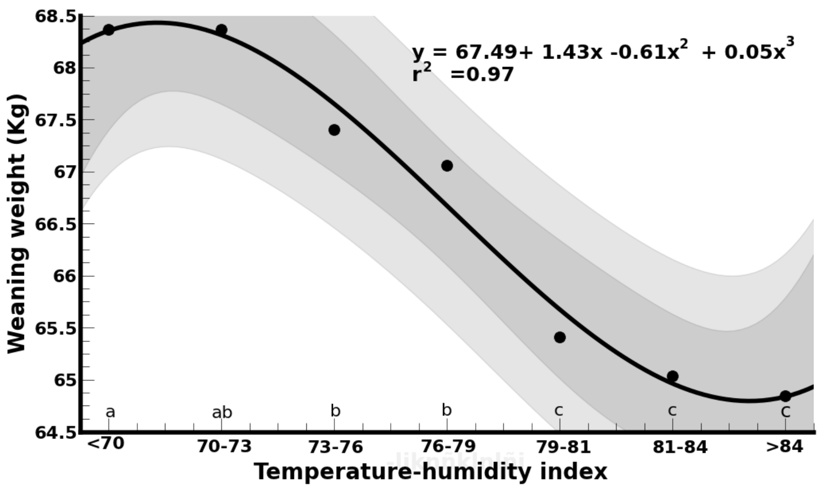

Fig. 7. The effect of THI the day of birth on weaning weight of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within THI, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

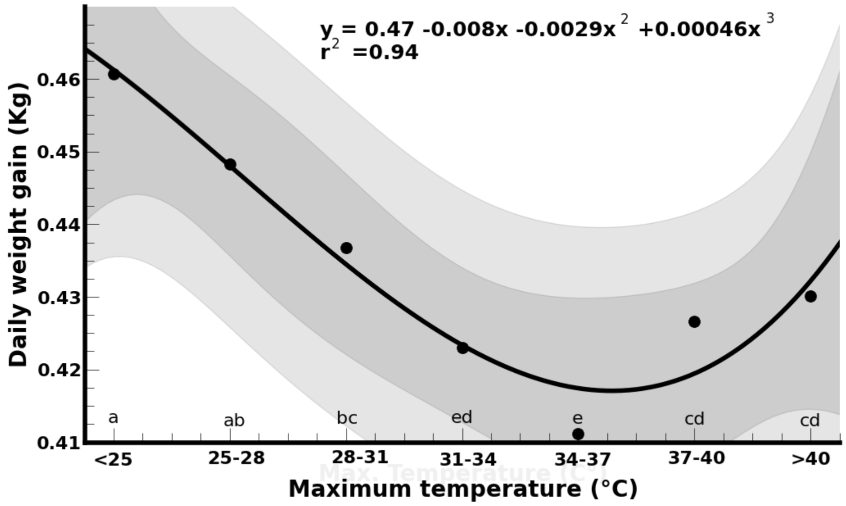

Fig. 8. The effect of ambient temperature the day of birth on daily weight gain of Hostein calves in a hot-arid environment in northern Mexico (26°N). Within temperature ranges, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

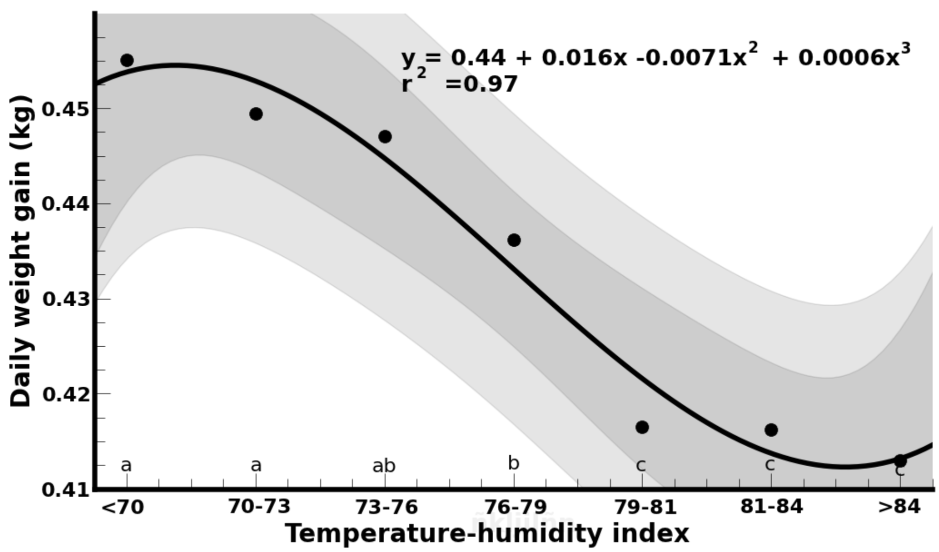

Fig. 9. The effect of temperature-humidity index (THI) the day of calving on pre-weaning daily weight gain of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within THI, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

Different from bBW, the increase of average maximum temperature one and two month prior to calving displayed real and significant correlation with the rest of growth traits (Fig.10, Fig. 11 Fig. 12. Fig 13.). Graphics showed that increment of high temperatures during the last months of gestation caused a gradual decrease of calves developing. This could be due to a carry-over effect, where high temperatures experienced by the fetus could be expressed after parturition.

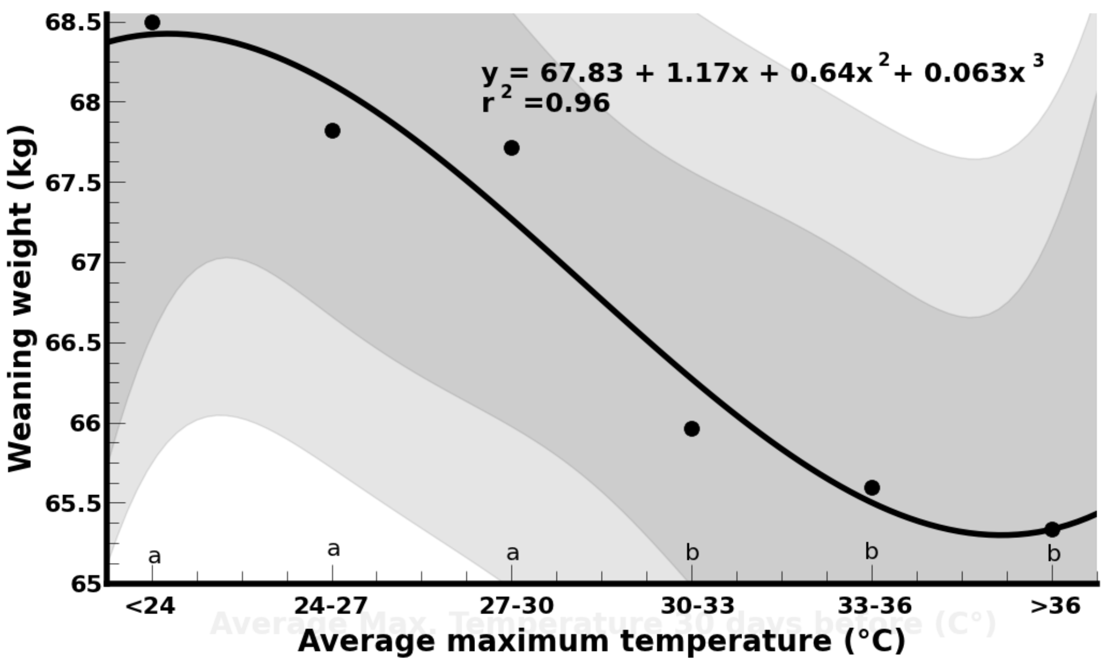

Fig. 10. The effect of temperature one month prior to calving on weaning weight of Holstein calves in a hot-arid environment in northern Mexico. Within temperature ranges, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

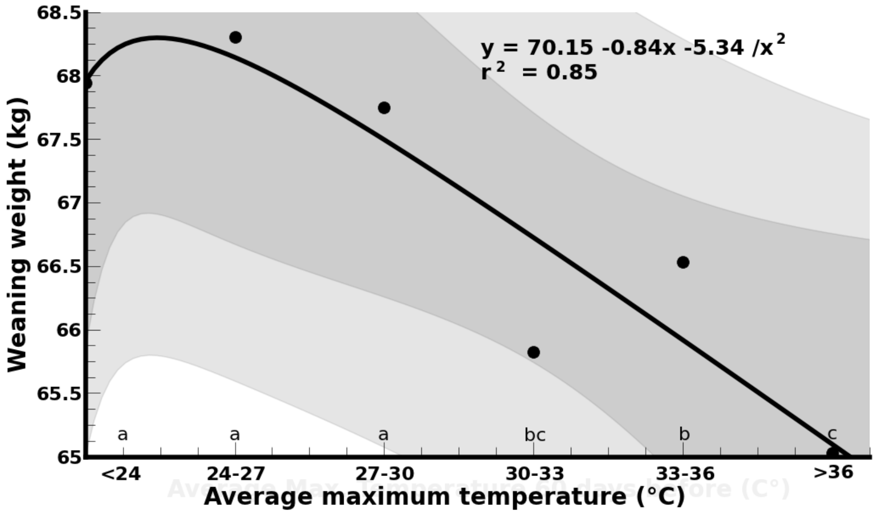

Fig. 11. The effect of temperature two month prior to calving on weaning weight of Holstein calves in a hot-arid environment in northern Mexico. Within temperature classes, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

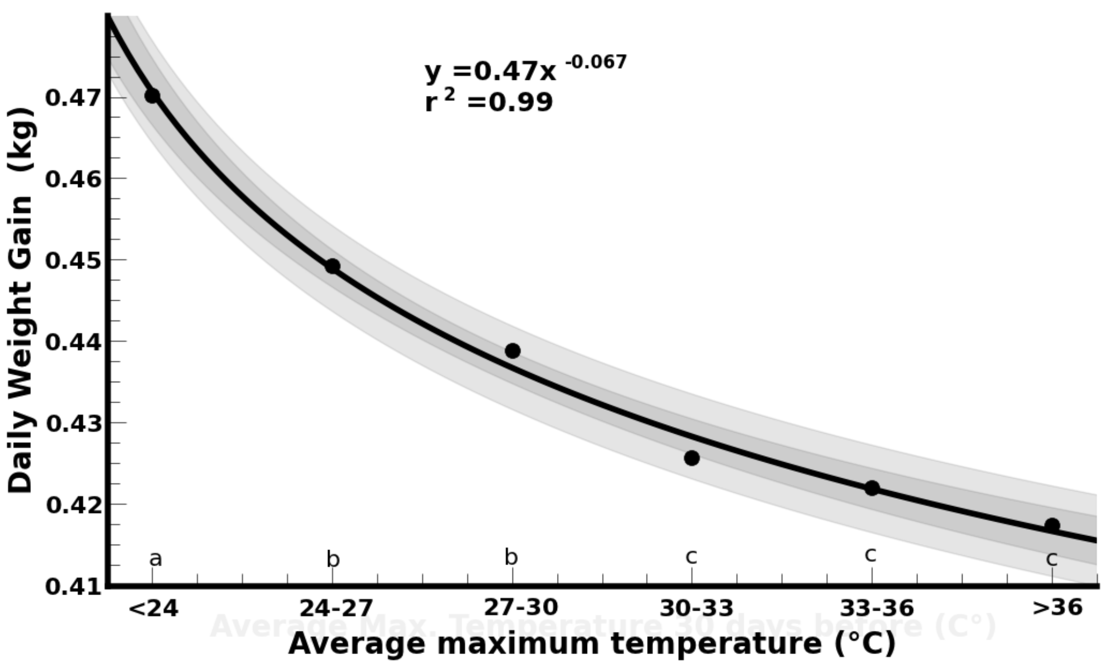

Fig. 12. The effect of temperature one month prior to calving on daily weight gain of Holstein calves in a hot-arid environment in northern Mexico. Within temperature classes, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

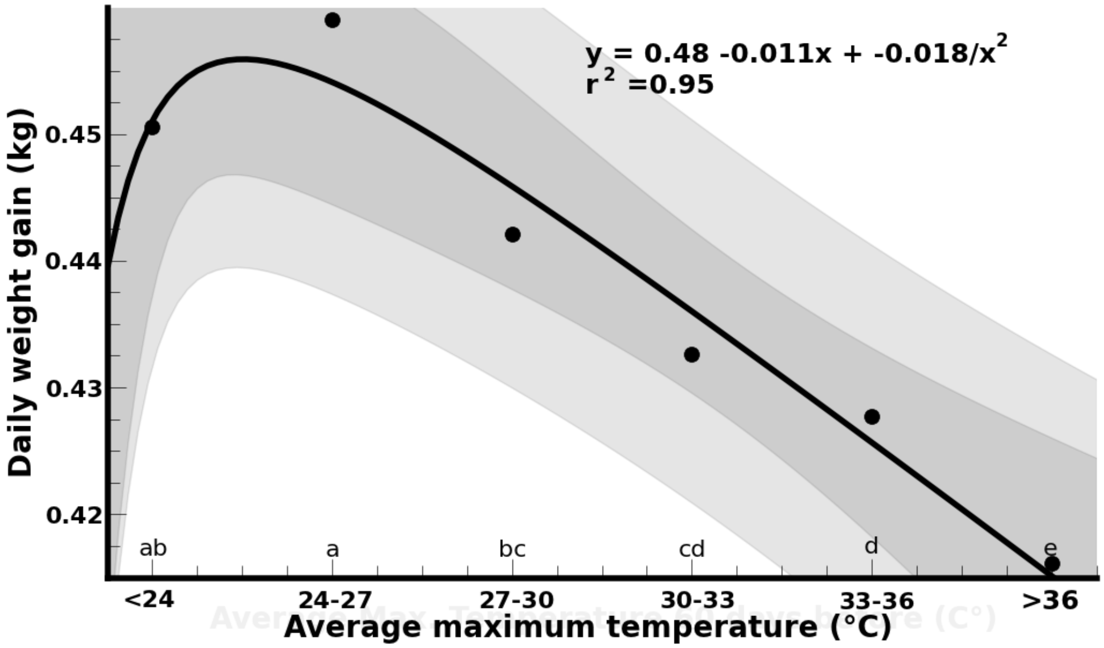

Fig. 13. The effect of temperature two month prior to calving on daily weight gain of Holstein calves in a hot-arid environment in northern Mexico. Within temperature classes, dissimilar letters differ ($P<0.01$). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

However, signs of stress such as painting, heart rate and increase of rectal temperature were not observed in calves experiencing intense heat load in this zone, and also mortality was not common in this environmental conditions (Mellado et al. 2013). Undoubtedly, there were changes in the animal behavior that allowed to dissipate the heat better than adult cows, like increasing of water intake (Hahn, 1997). Thus, It is confirmed a lesser signs of heat stress in calves than in adult cows (Singh and Newton, 1978a).

Likewise, other studies have shown that calves presented real differences of growth and weights between the summer and winter season. Calves showed the worst growth performance during July until October, with statistical significance compared with the rest of the months. (Fig 14 and 15) Calves which were weaned the first months of autumn, received extreme heat loads yet, as a result, low weaning weights were recorded. Similarly, these closely resemblance those of Tao et al. (2012), who also recorded lower weaning weights of calves during the hot season.

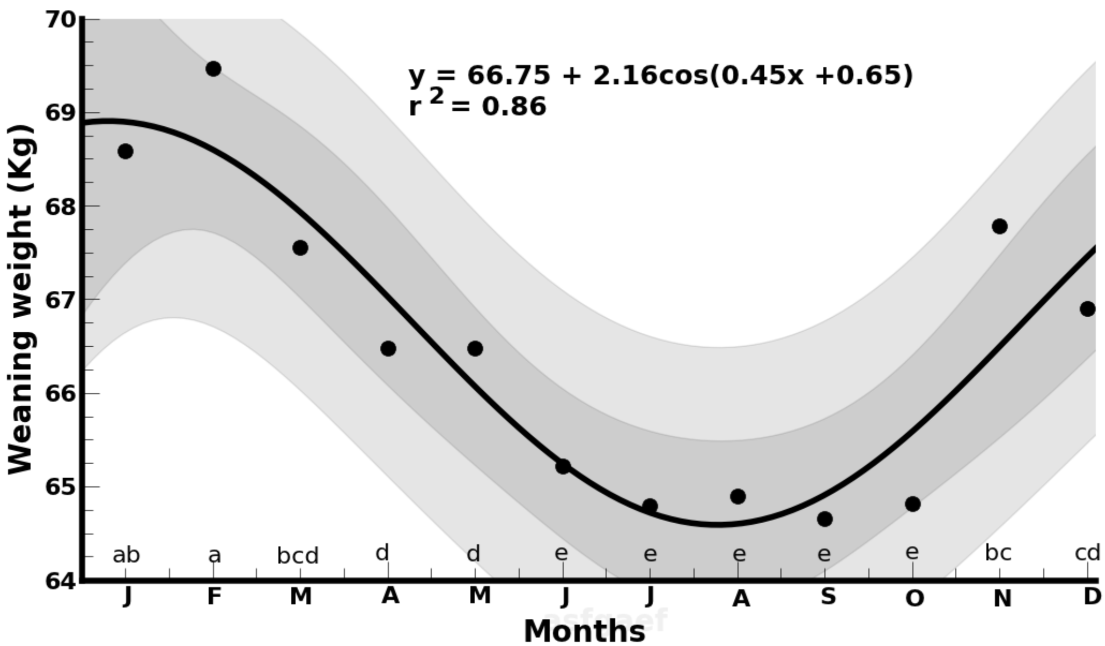

Fig. 14.The effect of month of calving on weaning weight (about 60 days) of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within months, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

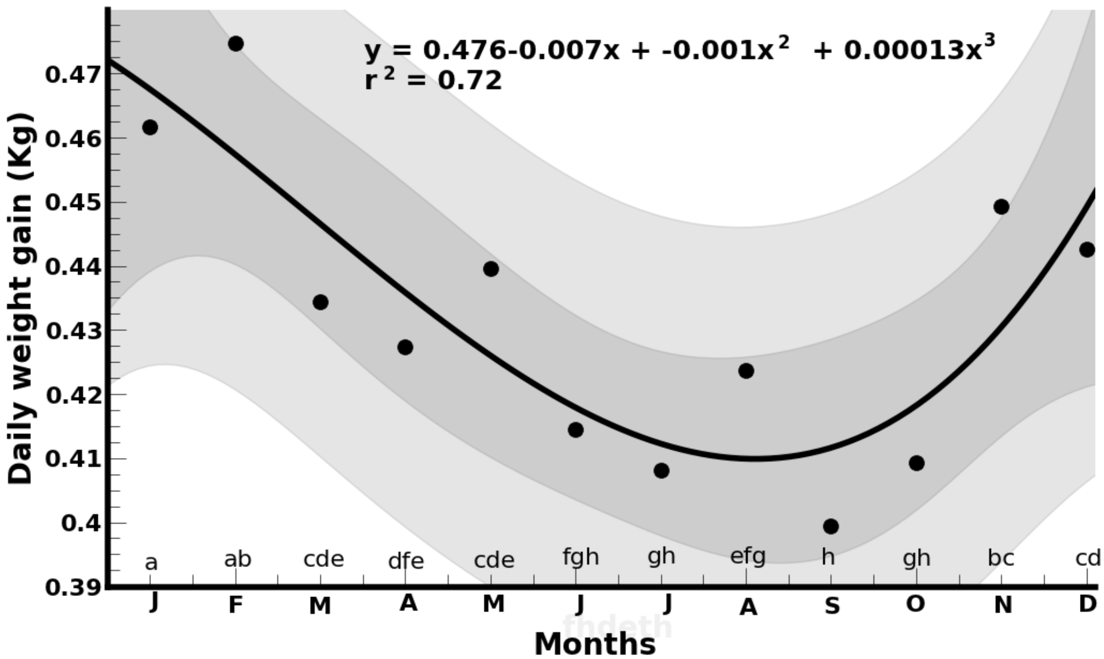

Fig. 15.The effect of month on daily weight gain of Holstein calves in a hot-arid environment in northern Mexico (26°N). Within months, dissimilar letters differ (P<0.01). The darkest bands indicate 95% confidence interval for predicted values. The clearest bands indicate the 95% confidence intervals for actual values.

When heat loads are no longer present during winter season, growth rate increased via compensatory growth (Hornick et al., 2000); nevertheless, more studies are needed, for all changes that heat-stress could cause, such as the decrease of triiodothyronine (T3) and thyroxine (T4) (Maloyan and Horowitz, 2002). Extreme heat load during the development phase could result in the impairment of fertility during the adult life. In addition, Mellado et al. (2012b) demonstrated in this zone that cows present certain degree of acclimation to heat-stress conditions; consequently, it does not provoke a drastic reduction in milk yield.

CONCLUSION

The growth traits were altered in different manners depending of climate variables. Evidently, there is a month of calving effect on bBW. If it is compared winter against summer season with bBW variable, means were not have significant differences between them (38.29 vs 38.26 kg), However, a comparison between spring season differing with the rest of the year, we found a real difference, (37.52 vs 38.53 kg; $p<0.001$). Calves decreased almost by 3%.These odd results could be explained for the next reasons: These Months had extremely high changes in temperature and besides, are the driest of the year with no precipitation. These could have more impact in cows with these conditions than cows which are already adapted to summer, with high temperatures all day long in a prolonged period. More studies are needed for assessing this phenomenon occurred in spring. Changes in grow rate of fetus occurred in a less than a month period due to high temperatures one and two month before calving did not have a clear effect in birth weights.

On the other hand, calves development seems to be impaired by summer season. Calves which grew in winter reached greater wBW than calves which grew in summer (68.11 vs 64.87), and also decreased by almost 5 %. Clearly, an animal had a drop on its dry matter intake; as a result, this provoked lower daily weight gain comparing the seasonal effect (0.453 vs 0.411 kg per d) and decreasing by 9%.

Extreme temperatures one and two months prior to calving affected the animal development, showing a clearly drop in wBW and DWG when temperatures were increased. A possible carry-over effect should be studied in a future for explaining the consequence that could possibly have to expose the dam to high loads and subsequently these could have a negative impact in the calf after the birth.

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