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Influence of temperature and humidity on the reproductive efficiency of dairy cattle

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Influence of temperature and humidity on the reproductive efficiency of dairy cattle

Abstract

The reproductive performance of 179 Holstein cows during the period from December 1978 through March 1984 was evaluated with respect to environmental temperature and humidity at the time of insemination. This study was conducted at the Western Kentucky University Farm, Bowling Green, Kentucky. Average monthly temperatures are similar to eastern Kansas, but average humidity is approximately 10 per cent higher. Average seasonal temperature and humidity values during the study period were 37.5°F, 81.2%; 60.2°F, 84.4%; 74.9°F, 89.4%; and 53.6°F, 85.3% for winter, spring, summer and fall, respectively. Conception rates observed were 54%, 46%, 15%, and 39% for winter, spring, summer, and fall, respectively. A complete randomized design was used to determine significant differences among seasonal conception rates and among months within seasons. Conception rates were significantly different ($P<.01$) among seasons but not significantly different ($P>.05$) among months within seasons.; Dairy Day, 1985, Kansas State University, Manhattan, KS, 1985;

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INFLUENCE OF TEMPERATURE AND HUMIDITY ON THE REPRODUCTIVE EFFICIENCY OF DAIRY CATTLE

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Summary

The reproductive performance of 179 Holstein cows during the period from December 1978 through March 1984 was evaluated with respect to environmental temperature and humidity at the time of insemination. This study was conducted at the Western Kentucky University Farm, Bowling Green, Kentucky. Average monthly temperatures are similar to eastern Kansas, but average humidity is approximately 10 per cent higher. Average seasonal temperature and humidity values during the study period were 37.5°F, 81.2%; 60.2°F, 84.4%; 74.9°F, 89.4%; and 53.6°F, 85.3% for winter, spring, summer and fall, respectively. Conception rates observed were 54%, 46%, 15%, and 39% for winter, spring, summer, and fall, respectively. A complete randomized design was used to determine significant differences among seasonal conception rates and among months within seasons. Conception rates were significantly different ($P<.01$) among seasons but not significantly different ($P>.05$) among months within seasons.

Introduction

Ideally, a cow should produce a calf every 12 months. This would provide the most offspring for possible inclusion into the herd and provide the highest lifetime milk production because a greater proportion of time would be spent in that part of the lactation when production is highest. To achieve the goal of a calf per year, the cow must conceive within 82 days postpartum. Various factors that affect reproductive performance have been identified but the degree of effect for each factor has not been quantified. This study was an initial step toward quantification of temperature and humidity effects on conception rate.

Procedures

Reproductive performance data from 179 Holstein cows of various ages were obtained from records maintained on the Western Kentucky University dairy herd. Data used were extracted from recordings made between December 1978 and March 1984. Performance data on cows that were culled prior to calving and on cows with incomplete lactations were not used in this study. No allowance was made with regard to age or number of lactations, even though it is realized that primiparous animals might react different than multiparous animals. Further, cows than exhibited gross health problems during the observation period were excluded from the study.

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Information obtained from individual cow records included calving dates, breeding dates, days in milk, days dry, and age at each breeding. These data were used to calculate services per conception, days open, calving interval, and days to first service. Individual cow data were grouped for month and seasonal analyses.

Seasonal, monthly and daily temperature data were obtained from records secured and maintained by the Kentucky Climatic Center under the auspices of the Department of Geography and Geology, Western Kentucky University. The Climatic Center is located approximately six miles from the Dairy Center. Humidity values used were also obtained from the Kentucky Climatic Center records. However, humidity recordings were taken at the Bowling Green-Warren County airport which is approximately four miles from the Dairy Center. Monthly and seasonal averages for temperature and humidity represented six and five years, respectively.

Results and Discussion

Conception rate and temperature were negatively correlated (-.15) with a coefficient of determination of 2.25% (Table 1). This non-significant (P>.05) correlation is not a true reflection of the relationship between conception rate and temperature because dairy cows are negatively affected by both low and high temperatures. This problem is explained quite well by the concepts of

Table 1. Seasonal variation in temperature[1] and conception rate.[2]

Season	Conception rate	Temperature °F
Winter[3]	54.09% (185)[7]	37.54
Spring[4]	46.4% (125)	60.20
Summer[5]	15.59% (150)	74.91
Fall[6]	38.99% (240)	53.55

[1] Values are five-year averages: Dec., 1978, through March, 1984.
[2] Values are five-year averages for Holstein cows.
[3] Inclusive dates December 22 through March 20.
[4] Inclusive dates March 21 through June 20.
[5] Inclusive dates June 21 through September 20.
[6] Inclusive dates September 21 through December 21.
[7] No. of observations.

"zone of Thermal Neutrality" and "Critical Temperatures". The zone of Thermal Neutrality is defined as the zone in which metabolic heat production is independent of air temperature. This zone is bounded by high and low critical temperatures. When the air temperature falls below the low limit, the animals' metabolic processes increase heat production to maintain body temperature, whereas, elevation of air temperature above the high limit stimulates the animals' body to accelerate heat loss through increased respiration rate and evaporative water loss through the skin. The correlation between conception rate and temperature in this study was determined with values collected throughout the year, including times when both high and low critical temperatures (limits) were exceeded.

Conception rate was highest in a temperature range of 46°F to 65°F (Table 2). The notable exception was February when the highest conception rate (58%) was obtained at an average temperature of 34°F. One possible explanation is that the cows have adjusted to cooler temperatures by this time coupled with the fact that daily temperatures are quite variable during February in Kentucky. Other studies have reported that air temperatures 0.9°F above or below the mean uterine temperature on the day of or day after insemination reduced conception rate. Thus, inseminations on the warmer days in February would possibly confound the data reported herein.

Table 2. Average monthly temperature, humidity, and conception rate.

	Month	Temperature[1] °C	Temperature[1] °F	Humidity[2] (%)	Conception[1] (%)
1.	January	-0.98	30.23	80.2	34.04 (63)[3]
2.	February	1.03	33.85	80.5	58.33 (57)
3.	March	7.96	46.33	79.9	43.48 (66)
4.	April	13.35	56.03	78.0	41.94 (44)
5.	May	18.24	64.83	85.9	40.74 (38)
6.	June	23.12	73.62	89.8	38.89 (25)
7.	July	26.17	79.1	90.5	21.43 (34)
8.	August	25.18	77.32	89.4	13.89 (44)
9.	September	20.88	69.58	88.1	22.37 (93)
10.	October	13.76	56.76	85.4	44.44 (81)
11.	November	8.96	48.12	83.5	35.19 (73)
12.	December	4.3	39.74	84.2	32.20 (78)

[1] Inclusive dates: Dec., 1978, through March, 1984.
[2] Inclusive dates: Jan., 1979, through March, 1984.
[3] No. of observations.

A significant ($P<.05$) negative correlation (-0.65) was observed between humidity and conception rate. Conception rate was significantly ($P<.01$) lower during the summer relative to fall, winter, and spring. In general, conception rate was affected ($P<.05$) by season but unaffected ($P>.05$) by months within a season.

Further work needs to be done on quantification of both temperature and humidity effects on reproductive efficiency and means to overcome the negative effects observed.