EVALUATION OF SHADE STRUCTURE ON LACTATION AND REPRODUCTIVE PERFORMANCE

W.W. Thatcher[1], H. Roman-Ponce[1], and D.E. Buffington[2]
Dairy Science Department[1]
Agricultural Engineering Department[2]
Institute of Food and Agricultural Sciences
University of Florida
Gainesville, Florida

Under Florida environmental conditions we have previously demonstrated that climatic conditions of high temperature and humidity lower reproductive efficiency and milk yield. Under the subtropical environment of Gainesville, Florida (average temperature 68 to 75°F; average relative humidity > 78%), both maximum environmental temperature the day after insemination and solar radiation the day of insemination had adverse effects on conception rates. These estimates of environmental effects on fertility, from a 10 year period involving 3500 to 5000 services, have been adjusted for various management and cow effects such as inseminator, breed, month, service number and age of cow. Within this geographical location and subtropical environment, both increasing maximum environmental temperature and solar radiation were associated with lower conception rates. When these specific climatic measurements were considered, no variability in conception rates from month to month was detected. This suggested that normal month effects may have been represented by climatological factors to a greater degree than nutritional and management factors. At least these type of quantitative characterizations suggest that reducing incident solar radiation may improve conception rates.

Since solar radiation is a radiant heat source contributing to the animals heat load in the sun, we were interested in determining whether a simple shade structure would improve dairy cow performance on a group basis. A shade structure of 2400 sq ft (30 x 80) was constructed and would accomodate approximately 30 to 33 cows (73 to 80 sq ft per cow) at a time. A gable type roof was supported with 6 inch pressure treated poles and the base of the roof was 12 feet above floor level. Top side of the roof was constructed of 26 gauge sheet metal painted white. The underside of the roof was lined with 1.5 inch styrofoam tongue and grooved insulation board. The floor of the shade structure was 4 inch reinforced concrete with a 2% slope. The concrete floor was flushed with water from three - 300 gallon dumptanks. Water flushing was done daily when cows were being milked and were not under the shade. In the early phases of the study, the combination of frequent water flushing and the concrete cause sore feet. This was minimized by reducing the amount of water flushing and limiting it to periods when cows were not present. The shade structure was in an East to West orientation to maintain a fairly fixed shade area during the day. Cows were both fed and had water available under the shade structure. Furthermore, they had an adjacent pasture area available at all times if they chose to remain on pasture without natural shade instead of under the shade on concrete. This pasture area is important during the evening and nights so cows can leave the shade to radiate their heat load to the sky.

Beginning on 8-28-74 (39 cows) and 5-25-75 (77 cows) cows were assigned randomly to either the shade structure or to an adjacent control pasture with no natural shade. Duration of the experiments for the summers of 1974 and 1975 were 11 and 21 weeks, respectively.

The 12 ft high gable-type roof with a 1.5 inch layer of insulation reduced greatly black globe temperatures under the shade structure during the period from sunrise to sunset, compared to the unshaded lot (Figure 1). This difference was due mainly to lowering the solar radiation under the structure. Black globe temperature is a measure which incorporates net radiation, dry bulb temperature, and wind speed.

Effectiveness of the shade on the physiological well being of the cows is evident when comparing respiration rate and rectal temperature responses among six cows exposed to shade (4 Holsteins and 2 Jerseys) versus no shade (n=6) during two 24 hour periods. Measurements were made every 2 hours starting at 8 a.m.; cows were confined to the shade structure throughout the 24 hour period. Clearly, cows in the shade structure had lower respiration rates (Figure 2) and rectal temperatures (Figure 3) than those exposed to the sun with no shade.

The question of practical importance is whether milk production and reproductive efficiency were improved in shaded cows? Cattle in the shade group had access to both feed and water under the structure. Furthermore, they had the option at any time of staying under the shade structure or in an open nearby pasture with no natural shade. During daylight hours, they usually remained under the structure; in the evening and night their time was spent in the pasture. Significant differences in milk production were detected between the two groups in an analysis considering variability due to treatment (shade and no shade), year (1974 and 1975), breed (Holstein, Jersey, Guernsey, Brown Swiss), interactions of the main effects, cows within year-breed-treatment, days pregnant and weeks of experiment. Mean daily milk yield was 10.6% (3.5 pounds more milk per day) greater for cows in the shade group (Table 1).

Table 1
LEAST SQUARES MEANS FOR AVERAGE DAILY MILK YIELD (lb/day)

	Shade	No-Shade	Percent Increase
Overall	36.56*	33.04	10.6%
1974	33.70	30.39	10.9
1975	37.44	33.92	10.4

*P<.10

Lactation curves for the two groups (Figure 4) were different (P<.01). During the first week on experiment, cows in the shade group increased their production, and they were more persistent throughout the trial. The difference in production widened during the last 10 weeks in 1975. These types of production responses during hot summer months in a subtropical environment are similar to production trends of dairy cows exposed to evaporative cooling in Arizona (Stott and Wiersma, 1974). The initial advantage of environmental modification is maintained throughout the experimental period and perhaps for the entire lactation.

Conception rate to all services was greater for cows exposed to shade (44.4% versus 25.3%, Table 2).

Table 2
REPRODUCTIVE PERFORMANCE OF SHADE EXPERIMENT
1974 and 1975

	Shade	No-Shade
Number of services	54	75
Number of cows pregnant	24	19
Percent conception	44.4	25.3**
Total services/total pregnancies	2.25	3.95
Early embryo death	0	2

** (P<.005)

This indicates that environmental modification improved reproductive performance as well as milk production. It is important to recognize that in this shade experiment control cattle had absolutely no natural shade. This may have magnified the production and fertility differences. It is interesting that under thermal stress conditions 25% of the services did result in pregnancies. Apparently some cows have the physiological capability to reproduce under heat stress conditions.

Mechanisms by which thermal stress lowers conception rates have been the subject of intense investigation by numerous laboratories. A clear, well documented answer to the question is not yet available for cattle. The adverse effects of heat stress are superimposed on a normal level of reproductive efficiency that is currently about 50%. This normal level of fertility is not satisfactory for the industry.

The potential physiological responses of the animal to thermal stress that lowers fertility probably are multifold, interrelated, and difficult to partition out simply as a direct temperature effect, a hormonal imbalance, a nutritional effect, a nervous system response, or a biochemical effect. The "Infertility Heat Stress Syndrome" doubtless is due to a combination of these factors that compromise the well being of the zygote and/or embryo in its microenvironment (reproductive tract).

Daily increases in ambient temperature that elevate rectal temperatures are environmental conditions that exceed thermoneutrality. If temperature of the reproductive tract (uterus or oviduct) is elevated, temperature itself may adversely affect the spermatozoa or developing embryo since in vitro high temperatures (102 F) lower subsequent embryo survival in laboratory animals.

Physiological responses of the cow after fertilization due to heat stress may also suppress fertility. One possibility is that a decrease in blood flow to the reproductive tract may affect water, nutrient, and hormonal availability to the uterus, as well as contributing to elevated uterine temperature. Furthermore, elevations in uterine temperature may physically affect hormonal binding to receptors within the uterus and uterine contractility. Additional research in these areas is needed to elucidate mechanisms by which thermal stress lowers fertility. However, practical systems of environmental modification, such as shade, will improve milk production and conception rates during periods of seasonal infertility.

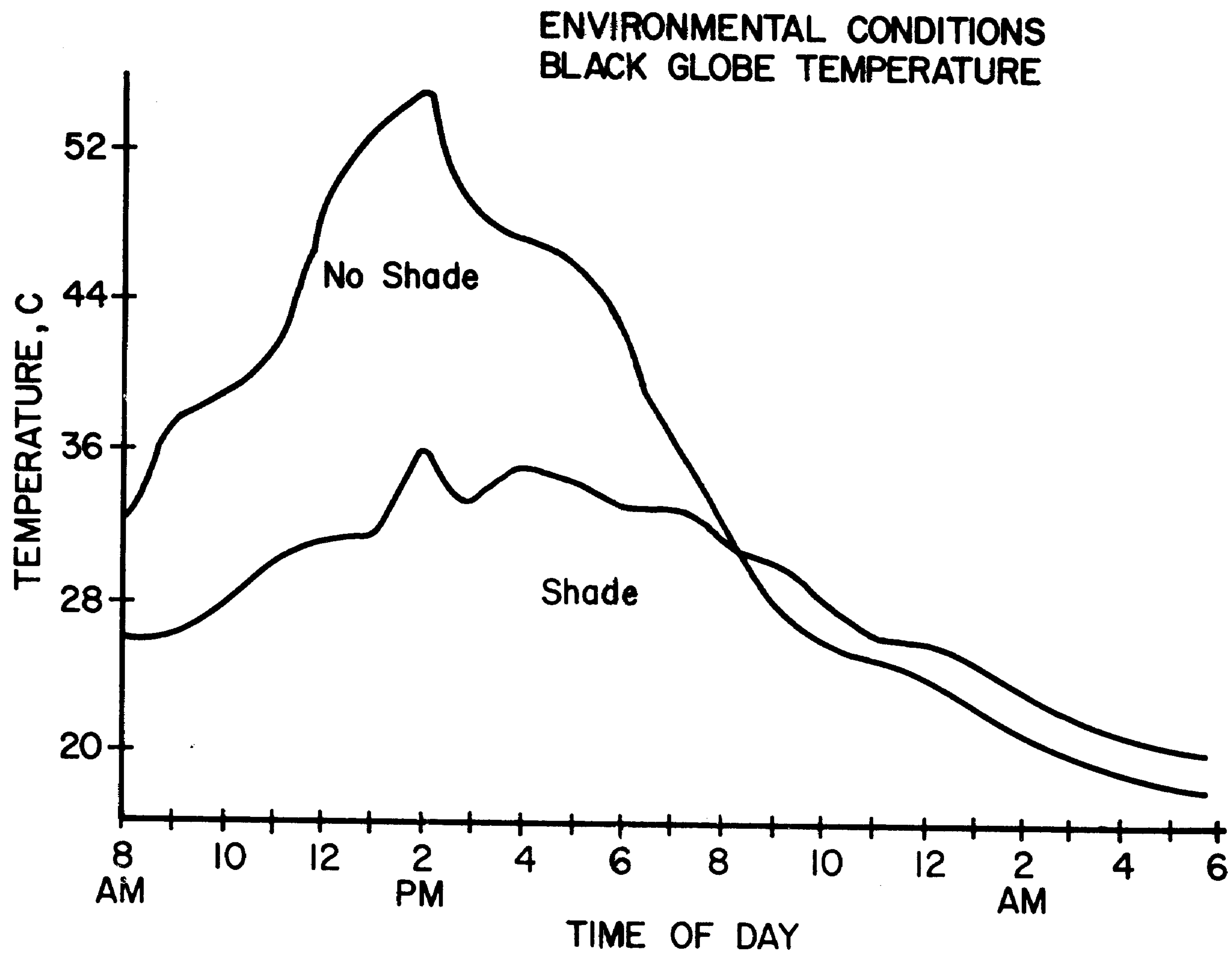

FIGURE 1: Black globe temperatures during a 24 hour period under a shade structure and pasture lot with no shade.

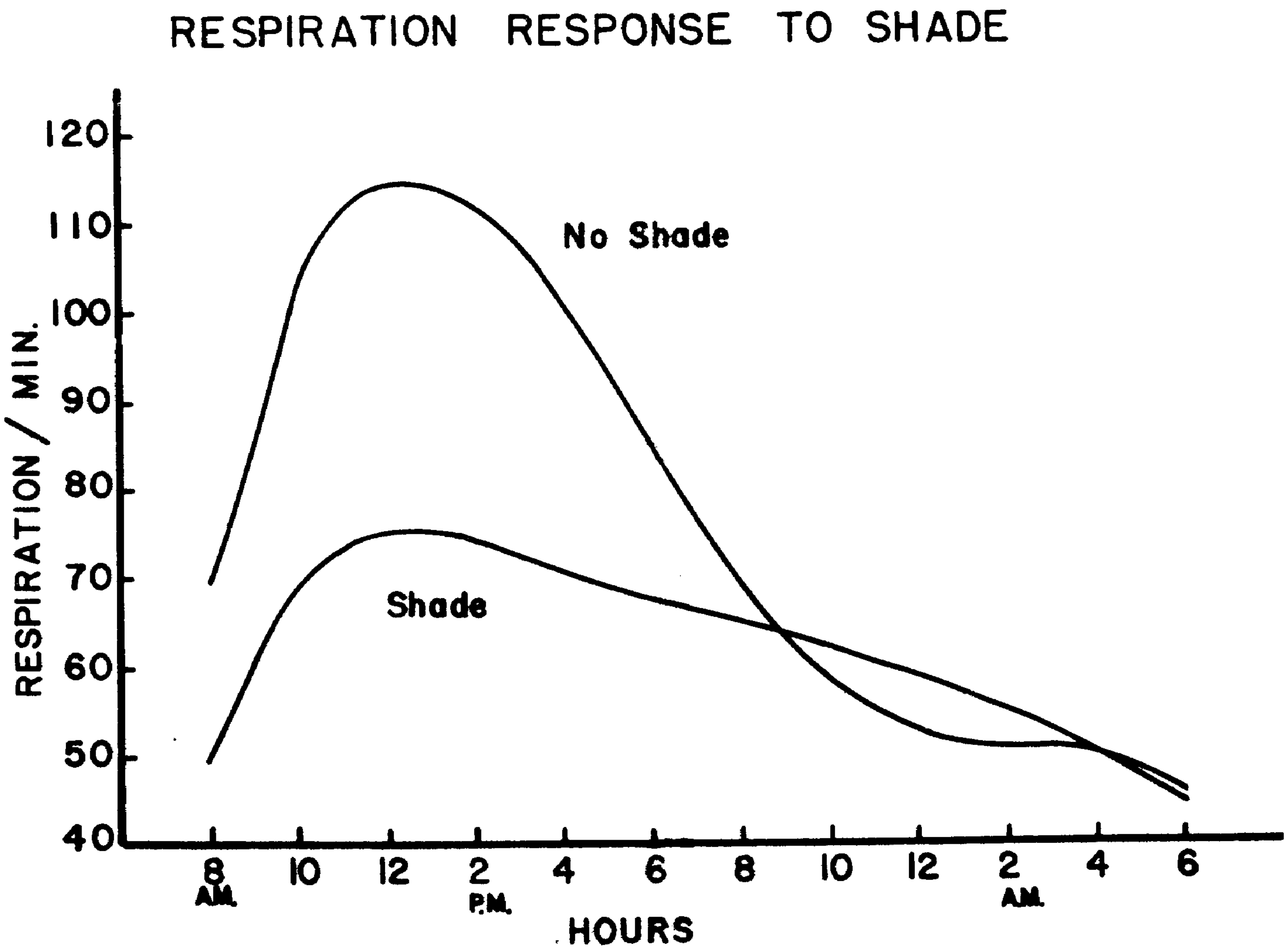

FIGURE 2: Respiration rate responses to shade and no shade.

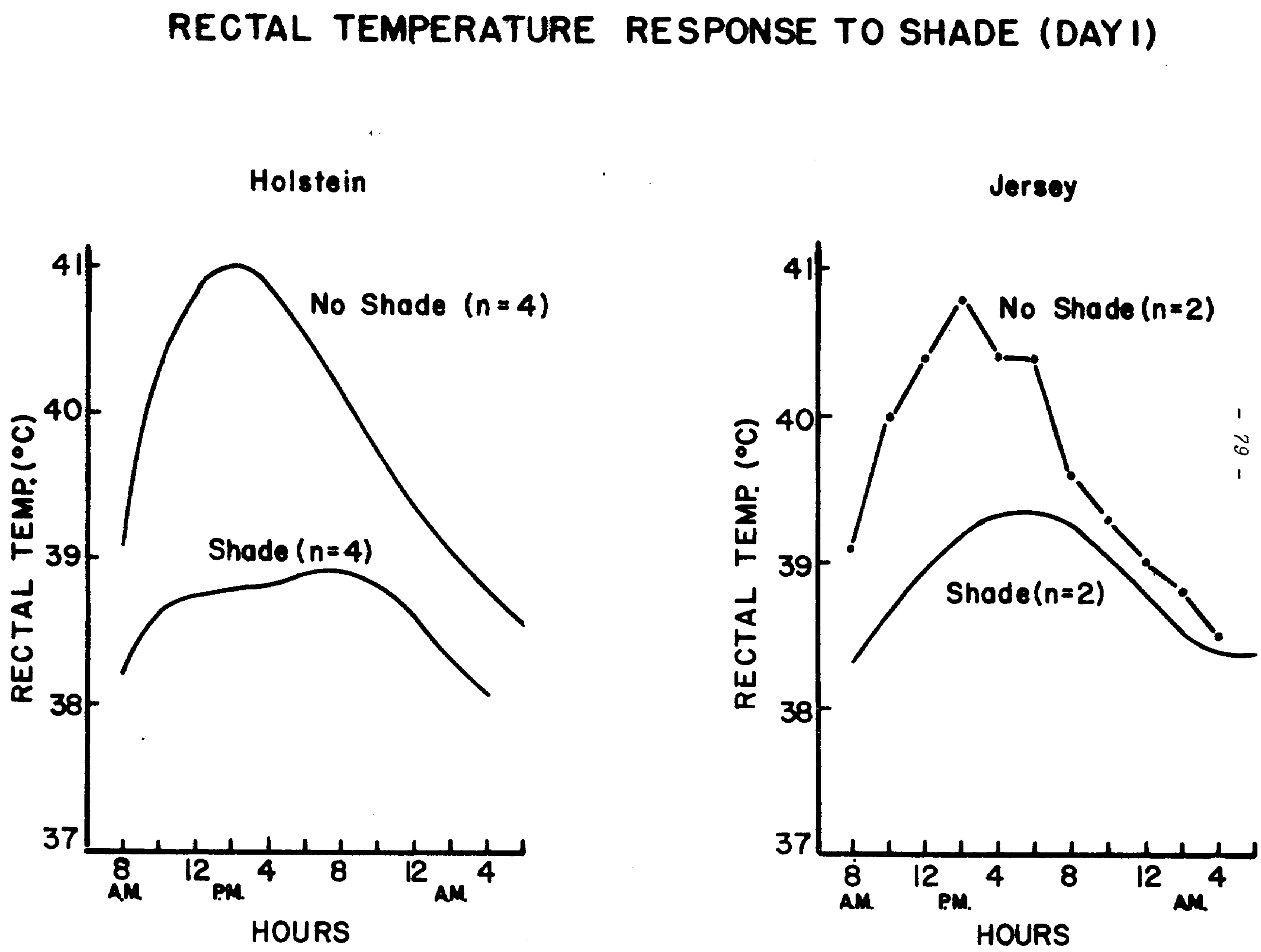

FIGURE 3: Rectal temperature responses to shade and no shade.

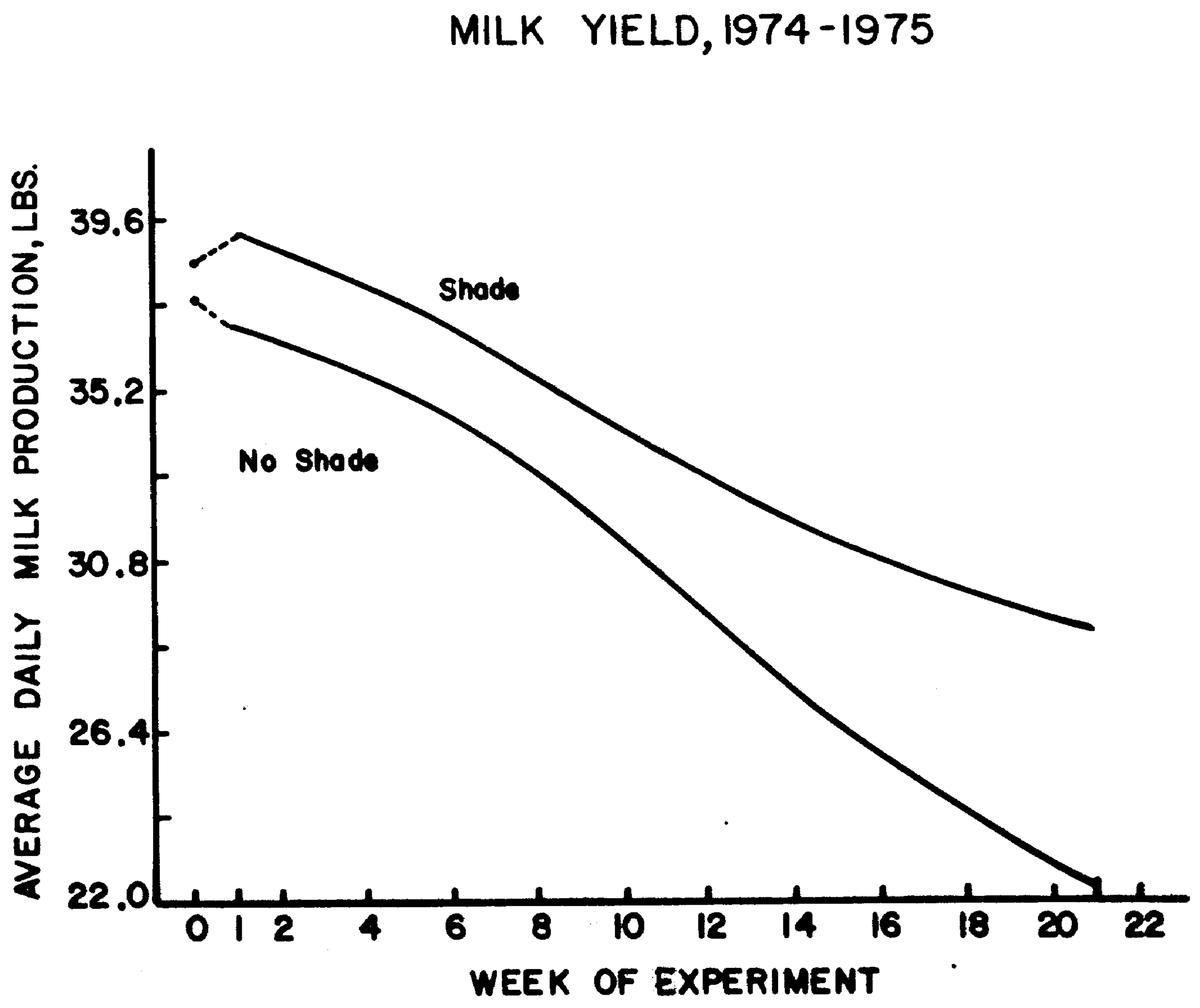

FIGURE 4: Lactation curve of cows exposed to shade or no shade.