

Adaptability of cross-bred dairy heifers to summer season measured by rectal temperature pulse rate and respiration rate

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RÉSUMÉ

Possibilité d'adaptation de génisses croisées à la saison chaude mesurée par la température rectale, la vitesse du pouls et le rythme respiratoire.

Les auteurs ont étudié au Pakistan la réponse de vaches laitières Sahiwal, Sahiwal × Jersey et Sahiwal × Holstein-Frison au stress de la saison sèche, en observant les variations journalières de la température rectale, du pouls et du rythme respiratoire, en fonction de la température et de l'humidité ambiantes.

Ces observations qui ont concerné 5 animaux par race ont montré qu'il n'existait pas de différence appréciable en ce qui concerne le mécanisme de la thermo régulation parmi ces trois races.

Les variations dans la fréquence du pouls suivent à peu près le même rythme chez les trois groupes d'animaux, avec une différence significative élevée ($P < 0,01$) entre les divers mois de l'été, le rythme le plus bas se situant à mi-juin où la température et l'humidité sont à leur niveau le plus bas et le rythme le plus élevé à la mi-juillet alors que l'humidité ambiante est à un niveau élevé.

Le rythme respiratoire qui représente le paramètre accusant le plus de variabilité entre les trois races, s'élève rapidement et de façon considérable chez les Sahiwal × Holstein-Frison, sensiblement moins chez les Sahiwal × Jersey pour atteindre son maximum à la mi-juillet ; alors que chez les Sahiwal ce rythme reste à peu près le même tout au long de la saison sèche.

Ils concluent que c'est la race Sahiwal qui supporte le mieux le stress thermique de la saison sèche.

INTRODUCTION

Sahiwal, an important breed of cattle in Pakistan, although is well adapted to extreme climatic conditions particular the heat stress during summer, has lower milk yield relative to the exotic dairy breeds of temperate zone. To improve the milk yield of local dairy cattle, it has now been agreed to adopt cross breeding of Sahiwal with Holstein Friesian and Jersey. The cross breeding programme in action have shown much higher milk production in F_1 as compared to Sahiwal. Whether such high

yielding crosses adapt well to our summer, would indicate the usefulness of aforementioned programmes along with other characteristics fixed for the ultimate goal. In addition to the effect of environmental condition on productive traits, the study of physiological reactions may lead to the assessment of adaptation. These parameters are commonly employed for such studies (8, 6, 7, 5).

The heat stress was, therefore, measured by some gross physiological parameters i.e., rectal temperature, pulse rate, and respiration rate throughout summer of 1977.

MATERIALS AND METHODS

The study was conducted on heifers of different genetic constitution i.e. purebred Sahiwal (S), Sahiwal × Jersey (S × J), and Sahiwal × Holstein Friesian (S × HF). Each genetic group contained 5 animals. The animals were maintained under uniform managerial conditions. Maximum environmental temperature and humidity was also recorded from April to September 1977.

The following physiological parameters were studied according to the method described by BLOOD and HENDERSON (3).

1. RECTAL TEMPERATURE

Rectal temperature (C°) was obtained by inserting the clinical thermometer in the rectum for 1 1/2 minute. Measurements were made at 4 PM daily.

2. PULSE RATE

Pulse was counted by palpating the coccygeal artery on the ventral side of the tail, for one minute, and was recorded as number/minute daily at 4 PM.

3. RESPIRATION RATE

Respiration per minute was recorded by feel of warm expired air from the animals nostrils, on the back of hand.

The observations recorded on rectal temperature, pulse rate, and respiration rate from heifers of three different genetic constitutions were tabulated and the average and standard error (\pm SE) were calculated for each parameter. The analysis of variance technique was used to find out any significant effects between groups within months and between months (9). In case of significant differences between breed groups and fortnights, Duncan Multiple Range Test (4) was used to further compare the mean differences.

RESULTS

The average values with standard error for rectal temperature, pulse rate and respiration rate recorded on heifers of purebred Sahiwal (S), Sahiwal × Jersey (S × J) and Sahiwal × Holstein Friesian (S × HF) for each month have been presented in tables I to III.

Average rectal temperature recorded in the evening in Sahiwal heifers (S) ranged from $38.8\text{ C}^\circ \pm 0.06$ to $39.2\text{ C}^\circ \pm 0.07$ from April

TABLE I : Average \pm SE monthly rectal temperature among heifers of different breed groups

Months	Average ambient temperature (C°)	Average relative humidity (p.100)	Breed groups			Overall average
			S (C°)	S x J (C°)	S x H F (C°)	
April	33.3	71	39.0 ± 0.05	38.9 ± 0.03	38.8 ± 0.04	38.9 ± 0.11 b
May	35.9	69	38.9 ± 0.10	38.8 ± 0.05	38.6 ± 0.04	38.7 ± 0.14 b
June	39.1	60	38.8 ± 0.06	38.8 ± 0.05	38.8 ± 0.06	38.8 ± 0.00 b
July	36.8	75	39.0 ± 0.07	39.4 ± 0.06	39.0 ± 0.08	39.1 ± 0.21 a
August	36.8	75	39.2 ± 0.07	39.3 ± 0.07	39.4 ± 0.08	39.3 ± 0.11 a
September	34.8	73	38.8 ± 0.06	38.8 ± 0.05	38.7 ± 0.03	38.8 ± 0.05 b
Overall average :			38.9 ± 0.10	39.0 ± 0.19	38.9 ± 0.20	38.9 ± 0.15
Means within a column followed by the same letter, do not differ significantly at $P < 0.01$.						

TABLE 2 : Average \pm SE monthly pulse rate per minute among heifers of different breed groups.

Months	Average ambient temperature (C°)	Average relative humidity (p.100)	Breed groups			Overall average
			B ₁	B ₂	B ₃	
April	33.3	71	81.0 \pm 0.70	80.0 \pm 0.49	80.0 \pm 0.60	80.0 \pm 0.33 b
May	35.9	69	83.0 \pm 1.15	84.0 \pm 0.50	79.0 \pm 0.96	82.0 \pm 1.53 b
June	39.1	60	82.0 \pm 0.80	79.0 \pm 0.63	80.0 \pm 0.67	80.0 \pm 0.83 b
July	36.8	75	87.0 \pm 1.11	86.0 \pm 0.89	87.0 \pm 1.00	86.0 \pm 0.35 a
August	36.8	75	89.0 \pm 0.55	90.0 \pm 0.46	91.0 \pm 0.52	90.0 \pm 0.51 a
September	34.8	73	80.0 \pm 0.53	81.0 \pm 0.41	80.0 \pm 0.42	80.0 \pm 0.46 b
Overall average :			84.0 \pm 1.45	83.0 \pm 1.64	83.0 \pm 1.98	83.0 \pm 1.62
Means within a column followed by the same letter, do not differ significantly at P < 0.01.						

B₁ = S ; B₂ = S \times J ; B₃ = S \times HF.

TABLE 3 : Average \pm SE monthly respiration rate per minute among heifers of different breed groups

Months	Average ambient temperature (°)	Average relative humidity (p.100)	Breed groups			Overall average
			B ₁	B ₂	B ₃	
April	33.3	71	32.0 \pm 0.50	35.0 \pm 0.42	35.0 \pm 0.51	34.0 \pm 0.86 d
May	35.9	69	35.0 \pm 0.71	36.0 \pm 0.61	40.0 \pm 0.79	37.0 \pm 1.56 d
June	39.1	60	35.0 \pm 0.84	40.0 \pm 1.14	50.0 \pm 1.65	41.0 \pm 4.47 c
July	36.8	75	37.0 \pm 0.81	52.0 \pm 1.50	65.0 \pm 4.90	52.0 \pm 8.00 b
August	36.8	75	40.0 \pm 0.88	61.0 \pm 1.49	77.0 \pm 1.64	59.0 \pm 10.59 a
September	34.8	73	28.0 \pm 0.78	37.0 \pm 0.86	47.0 \pm 0.92	37.0 \pm 5.38 cd
Overall average :			35.0 \pm 1.68(c)	43.0 \pm 4.40(b)	52.0 \pm 6.5(a)	43.0 \pm 4.05
Means within a column followed by the same letter, do not differ significantly at P < 0.01.						

TABLE 4 : Analysis of variance of various physiological parameters showing the effects of breed groups and fortnights

Source of variation	Degree of freedom	Mean square of :		
		Rectal temperature	Pulse rate	Respiration rate
Breeds	2	0.30	29.75	2293.61***
Months	5	2.08***	295.19***	1468.89***
Breeds x Months	10	0.226	18.794	221.16***
Error	72	0.26	23.87	36.88

*** = Highly significant at P < 0.01.

to September. Similar trend for rectal temperature was observed in crossbred heifers i.e. S × J, 38.8 to 39.4 C° and S × FH, 38.6 to 39.4 C°. The differences due to breed groups was found to be non-significant, but there was a significant difference in the various months of the summer season (table IV). The average rectal temperature considered for each heifer separately over the experimental period ranged from 38.7 to 39.2 C° in S, 38.9 to 39.4 C° in S × J and 38.8 to 39.0 C° in S × FH. This indicated that there was no appreciable difference in the thermoregulatory mechanism among the three groups.

The pulse rate in purebred Sahiwal heifers (S) was 81.0 ± 0.70 in April, 83 ± 1.15 in May, and 82 ± 0.80 in June. It increased to 87 ± 1.11 in July and 89 ± 0.55 in August, falling again to 80 ± 0.53 in September. These values in Sahiwal × Jersey heifers (S × J) were 80 ± 0.49 , 84 ± 0.50 , 79 ± 0.63 during the months of April, May and June, respectively. It increased to 86 ± 0.89 in July and 90.0 ± 0.46 in August, falling to 81 ± 0.41 in September. The pulse rate in Sahiwal × Holstein Friesian heifers (S × HF) was 80 ± 0.60 , 79 ± 0.96 , and 80 ± 0.67 in the months of April, May and June, respectively. It increased to 87 ± 1.00 in July and 91 ± 0.82 in August, while it was 80 ± 0.42 in the month of September. There were highly significant ($P < 0.01$) difference among different months of summer but there was no significant difference among three breeds under study as well as their interaction (table IV).

The maximum average ambient temperature during this study was 39.1 C in the month of June and the relative humidity value during July was 75 p. 100, respectively. The results indicated that the maximum ambient temperature did not affect the pulse rate very much, but the comparatively high relative humidity raised the pulse rate appreciably. The individual differences in rectal temperature, respiration and pulse rate for heifers within different groups were quite marked.

Respiration rate was highly significant among different breed, during various months of the summer season and also for breeds × months interaction. The average respiration rates of heifers of group S were 32 ± 0.50 , 35 ± 0.71 and 35 ± 0.84 during the months of April, May and June respectively. It

increased to 37 ± 0.81 and 40 ± 0.88 during the months of July and August, falling again to 28 ± 0.78 during the month of September. In heifers of group S × J, the respiration rate was 35 ± 0.42 , 36 ± 0.61 and 40 ± 1.14 during the months of April, May and June respectively. The respiration rate increased to 52 ± 1.50 and 61 ± 1.49 during July and August, dropping again to 37 ± 0.86 during the month of September. The average respiration rate in heifers of group S × FH was 35 ± 0.51 , 40 ± 0.79 and 50 ± 1.65 during the month of April, May and June. It increased to 65 ± 4.9 and 77 ± 1.64 during the months of July and August. The average respiration rate in group S × FH was 47 ± 0.92 during the month of September. The average respiration rate, among the three groups month-wise, was lowest in the purebred Sahiwal heifers, while the highest respiration rate was recorded in Sahiwal × Holstein Friesian crossbred (fig. 1).

DISCUSSION

In the present study, it was observed that respiration rate was the most variable parameter among different breed groups. SEATH and MILLER (8) explained that one degree rise in ambient temperature caused 41 to 43 time as much influence on respiration rate. When the ambient temperature increases, animals try to adjust themselves to this external seasonal fluctuation, respiration rate therefore, increases during adaptation. Increase in body temperature has been noticed when atmospheric temperature increased upto 90 F° in lactating cow, whereas relative humidity has not shown such relationship (5). This does not indicate that heat tolerance reactions are not influenced by humidity. Most of the work reported in this regard pertains to relative humidity which have shown no relationship. Probably absolute humidity does have importance in heat tolerance reactions. Pulse rate also increases with the increase in ambient temperature (5). Contradictory report also exists in literature (8) where pulse rate has been shown to be less affected by either temperature or relative humidity.

Summer season studied in this project was from April through September. During this period maximum ambient temperature ranged from 31 to 39.1 C°. Relative humidity during

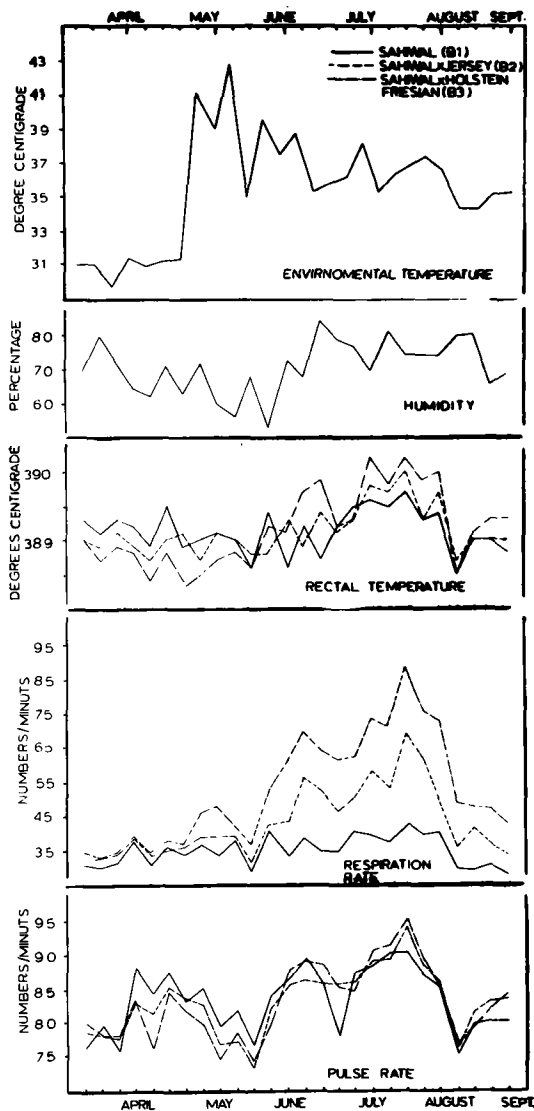


FIG.1.EFFECT OF ENVIRONMENTAL TEMPERATURE, AND HUMIDITY ON RECTAL TEMPERATURE, RESPIRATION RATE AND PULSE RATE OF PURE AND CROSS-BRED HEIFERS.

the same period was 60 to 75 p. 100. These two components of the season were the major stressful factors as other like feeding and management were kept optimum and constant to a greater extent.

The study under report showed minor differences in the rectal temperature with respect to crossbred and purebred Sahiwal. However, the individual heifers showed variable response to the summer condition. Similar findings have been reported by JOHNSTON and BRANTON (5). Relative humidity has shown comparatively more relationship with rectal temperature and relative humidity. However, the thermoregulatory mechanism of different breed groups under study seems to be efficient.

Similar trend was observed when pulse rate was examined. Here again the environmental temperature showed least influence, but relative humidity showed appreciable change. Respiration rate showed marked variations among different breed groups, lowest being in pure Sahiwal and highest in Sahiwal × Holstein Friesian heifers. It may be noted that individual variation within the same breed were also apparent. Both ambient temperature and relative humidity seem to be closely related to respiration rate. JOHNSTON and BRANTON (5) have shown similar findings and were unable to explain certain inconsistencies, apparent in vapour pressure correlation. BHATTACHARYA *et al.* (2) reported that pulse rate and respiration rate was affected by seasonal variation and respiration was lowest in Sahiwal breed. BEAKLEY and FINDLAY (1) also supported the view that heart rate of experimental animals increased with increase of environmental temperature above 20 C° and with increasing humidity above 30 C°. They also reported that effects of humidity on heart rate at 30 C° were not significant, but the effect of increasing humidity to near saturation at 35 C° had significant effect. It may be seen that purebred Sahiwal heifers are quite heat tolerant as indicated by the three parameters under consideration. The animals of Sahiwal × Jersey (S × J) origin were better than the animals of other group which showed much higher pulse and respiration rate.

SUMMARY

The study was conducted on heifers of different genetic make up, each having 5 animals. These animals were examined for various physiological parameters with response to summer stress. Rectal temperature did not differ much among the three groups and it ranged from 38.8 ± 0.6 to 39.2 ± 0.07 C° in Sahiwal, 38.6 to 39.0 C° in Sahiwal × Holstein Friesian and 38.8 to 39.0 C° in Sahiwal × Jersey. Pulse rate was higher in Sahiwal × Holstein Friesian (91.0 ± 0.52) while it was 90.0 ± 0.46 in Sahiwal × Jersey and 89.0 ± 0.55 in Sahiwal in the month of August. Average respiration rate was 32.0 ± 0.50 in

Sahiwal, which increased to 37.0 ± 0.81 in July. In Sahiwal \times Jersey respiration rate was 35.0 ± 0.42 which increased to 61.0 ± 1.49 during July. A further increase was noted (80.0 ± 1.64) during August in Sahiwal \times Holstein Friesian.

RESUMEN

Posibilidad de adaptación de becerras mestizas a la estación de verano medida por la temperatura rectal, la rapidez del pulso y el ritmo respiratorio

Los autores estudiaron, en Paquistán, la reacción de vacas lecheras Sahiwal, Sahiwal \times Jersey y Sahiwal \times Holstein al « stress » de la estación seca al observar las variaciones diarias de la temperatura rectal, del pulso y del ritmo respiratorio con arreglo a la temperatura y a la humedad ambiente.

Estas observaciones a partir de 5 animales por raza mostraron que no existía diferencia notable en lo que concierne al mecanismo de la termorregulación entre estas tres razas.

Las variaciones de frecuencia del pulso siguen casi el mismo ritmo en los tres grupos de animales, con una diferencia significativa elevada ($P < 0,01$) entre los varios meses del verano, el ritmo más bajo ocurriendo a mediados de junio cuando la temperatura y la humedad están más bajas y el ritmo más elevado a mediados de julio mientras la humedad ambiente es más elevada.

El ritmo respiratorio, que representa el parámetro más variable entre las 3 razas, aumenta rápido y considerablemente en los Sahiwal \times Holstein-Frison, notablemente menos en los Sahiwal \times Jersey, para llegar a su máximo a mediados de julio (mientras que en los Sahiwal, este ritmo queda poco más o menos el mismo a lo largo de la estación seca).

Concluyen que es la raza Sahiwal que soporta lo mejor el « stress » térmico de la estación seca.

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