

## Studies on physiological responses to different cart-loads, post-work regain pattern and distress score in Kankrej and Jersey×Kankrej bullocks in comfort and stressful seasons\*

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The changes in physiological responses are used to know adverse effects of heat stress and work load. There is no documentation on physiological responses and normalization pattern in Kankrej and its crossbreds to work stress. Hence, the present investigation was undertaken to compare magnitude of changes in physiological parameters, rate of regain and distress score in Kankrej and Jersey×Kankrej bullocks subjected to different carting loads on kutcha farm road during stressful and comfort seasons.

Twelve bullocks, 6 each of Kankrej and Jersey×Kankrej crossbred were subjected to carting loads: total cart load (payload) equivalent to 150 (340 kg), 200 (620 kg), 250 (900 kg) 300 (1180 kg) per cent of body weight of individual bullock for 3 hours in both morning (8.00–11.00) and afternoon (14.30–17.30) sessions of stressful (standard weeks 19 to 23rd May to 10th June, THI:  $88.15 \pm 0.70$ ) and comfort (standard weeks 49 to 52 and 1 to 3, 3rd December to 21st January, THI:  $74.04 \pm 0.41$ ) seasons. A total of 192 carting trials were carried out on kutcha farm road using modified single animal pneumatic-tyred cart.

Respiration rate (RR/min) and rectal temperature (BPF) of bullocks were measured 5–10 min prior to work, as initial and then-after at the end of 1st, 2nd and 3rd hour ( $\pm 10$  min) of continuous carting. The RR and BT recorded four times during each trial, i.e. initial (0) and at 1, 2 and 3 h of continuous work were designated as periods PO, P1, P2 and P3 or till the stage of total inability of the bullocks to work. To study the pattern of normalization, RR and BT were also

recorded at 10, 20 and 30 min after the end of third hour of carting. The corresponding post-work values were designated as PW10, PW20 and PW30.

Behavioural manifestations and distress symptoms of the bullocks to work stress/fatigue viz., salivation, frothing, protrusion of tongue, movement inhibition, leg incoordination, temperamental changes etc. were recorded at every 10–15 min interval during carting. An attempt was made to evaluate and compare Kankrej and Jersey×Kankrej bullocks for the degree of distress on the basis of distress score worked out using modified fatigue score developed by Upadhyay and Madan (1985, 1987).

The observations on physiological parameters were subjected to analysis of variance using 5-factors factorial randomized block design considering breed, season, load, time/session and period as undependable variables (Snedecor and Cochran 1989). The behavioural distress symptoms were compared for different seasons, work-intensity and breed groups.

### Physiological responses of the working bullocks

The respiration rate (RR) and rectal temperature (BT) of the bullocks subjected to hauling 4 cart loads during summer and winter seasons are presented in Table 1.

Overall RR (per min) and BT (OF) of the bullocks were 31.20 and 101.50 in Kankrej and 35.80 and 101.77 in crossbreds. The RR differed significantly ( $P < 0.01$ ) but BT did not differ between breeds. During summer, RR and BT were significantly higher by 41.96% and 1.07%, respectively, than in winter (39.31 vs 27.69 /min, 102.08 vs 101.09 °F). Load imposed on the bullocks did affect RR, but not BT. Surprisingly, at higher loads L3 and L4, the RR were lower than those observed at lower loads of L1 and L2. The BT remained identical for all the four loads (Table 1). The time or session of the day significantly ( $P < 0.01$ ) affected the physiological parameters of the bullocks. RR and BT were 2.68 /min and 0.33°F higher during afternoon over morning

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session. The RR rose by 66.13, 98.83 and 99.64%, whereas BT increased by 0.61, 1.03 and 1.29%, respectively, at 1, 2 and 3 hour of work over those at pre-work values. Thus, increase in RR per min and BPF were maximum in 1st hour (+14.87, +0.62) followed by those during 2nd hour (+7.02, +0.42) and minimum during 3rd hour (+0.18, +0.26; Table 1).

The breed×season, breed×load, breed×time and breed×period interactions were significant ( $P<0.01$ ) with respect to RR and BT of the bullocks subjected to carting trials. As compared to winter, the RR and BT during summer were greater by 35.17 and 1.25% in Kankrej and 66.51 and 0.91% in crossbreds. The crossbreds showed higher RR and BT to the tune of 11.89 and 0.10 during summer and 2.32 and 0.44 during winter, respectively, than the Kankrej. These findings supported the previous observations of Maurya and Devadattam (1982) and Upadhyay and Madan (1985).

The crossbreds exhibited 17 to 30% rise in RR and 0.02 to 0.04% increase in BT at lower loads (L1 and L2), whereas at higher loads (L3 and L4) the increase in RR was only 3.60 to 7.60% and in BT by 0.20 to 0.45% when compared with values of Kankrej (Table 1). The findings indicated that at lower intensity of work, crossbreds could dissipate heat by

sufficiently increasing RR resulting in lesser rise in BT, whereas at heavier work the lesser magnitude of increase in RR over the actual requirement resulted in the rate of rise in BT by 10 times (0.20 to 0.45 vs 0.02 to 0.04%). In crossbreds the sweating at higher loads might have helped in dissipating heat from the body, but did not appear to be adequate to cope up body mechanisms.

Kankrej had almost similar RR (30.72–31.67/min) during morning and afternoon, but in crossbreds, it increased by 13.10% (4.40/min) during the afternoon session due to thermal and/or work stress. The rate of rise in BT during afternoon over morning was also almost double in crossbreds in comparison to Kankrej (0.43 vs 0.24°F). During morning and afternoon, crossbreds showed higher RR by 2.69 and 19.94% and BT by 0.17 and 0.35% as compared to those of Kankrej bullocks (Table 1).

The overall increase in physiological parameter of Kankrej and crossbreds due to 3 h of carting was 85.53 and 111.33% for RR and 1.10 and 1.46% for BT over pre-work values. The RR values were +12.60, +6.87 and -1.03% in Kankrej and +17.15, +7.16 and +1.41% in crossbreds at P1, P2 and P3 over the preceding periods (Table 1). Similar to present findings, greater rise at the end of work or over

Table 1. Respiration rate (RR/min) and rectal temperature (BT °F) of Kankrej and crossbred bullocks subjected to carting (Mean±SE)

| Factors                 | N   | Kankrej                  |             | Crossbreds               |             | N    | Pooled                   |       |                           |      |
|-------------------------|-----|--------------------------|-------------|--------------------------|-------------|------|--------------------------|-------|---------------------------|------|
|                         |     | RR/min                   | BT (°F)     | RR/min                   | BT (°F)     |      | RR/min                   | CV%   | BT (°F)                   | CV%  |
| Season                  |     |                          |             |                          |             |      |                          |       |                           |      |
| Summer                  | 336 | 35.86±0.06               | 102.13±0.03 | 47.75±1.11               | 102.23±0.03 | 672  | 39.31 <sup>a</sup> ±0.64 | 42.28 | 102.18 <sup>a</sup> ±0.03 | 0.73 |
| Winter                  | 336 | 26.53±0.34               | 100.87±0.03 | 28.85±0.39               | 101.31±0.03 | 672  | 27.69 <sup>b</sup> ±0.26 | 24.74 | 101.09 <sup>b</sup> ±0.02 | 0.53 |
| Load                    |     |                          |             |                          |             |      |                          |       |                           |      |
| L1 (340 kg)             | 168 | 31.04±0.80               | 101.59±0.06 | 36.84±1.04               | 101.61±0.07 | 336  | 34.16 <sup>b</sup> ±0.86 | 46.11 | 101.60±0.04               | 0.79 |
| L2 (620 kg)             | 168 | 31.86±0.80               | 101.46±0.06 | 41.45±1.72               | 101.84±0.07 | 336  | 36.66 <sup>a</sup> ±0.98 | 49.08 | 101.65±0.05               | 0.91 |
| L3 (900 kg)             | 168 | 31.14±0.77               | 101.52±0.07 | 32.25±0.76               | 101.72±0.05 | 336  | 31.69 <sup>c</sup> ±0.54 | 31.29 | 101.62±0.04               | 0.78 |
| L4 (1180 kg)            | 168 | 30.31±0.73               | 101.43±0.08 | 32.66±0.76               | 101.89±0.05 | 336  | 31.04 <sup>c</sup> ±0.53 | 30.90 | 101.66±0.05               | 0.86 |
| Time of the day         |     |                          |             |                          |             |      |                          |       |                           |      |
| Morning                 | 336 | 30.72±0.56               | 101.38±0.05 | 33.60±0.72               | 101.55±0.04 | 672  | 32.16 <sup>a</sup> ±0.46 | 36.97 | 101.47 <sup>a</sup> ±0.03 | 0.77 |
| Afternoon               | 336 | 31.67±0.54               | 101.62±0.05 | 38.00±1.22               | 101.98±0.05 | 672  | 34.84 <sup>b</sup> ±0.72 | 48.28 | 101.80 <sup>b</sup> ±0.04 | 0.92 |
| Period/Duration of work |     |                          |             |                          |             |      |                          |       |                           |      |
| P0                      | 96  | 21.56±0.36               | 100.92±0.05 | 22.73±0.56               | 100.94±1.05 | 192  | 22.15 <sup>a</sup> ±0.32 | 19.85 | 100.93 <sup>a</sup> ±0.53 | 7.27 |
| P1                      | 96  | 34.16±0.92               | 101.47±1.06 | 39.88±1.68               | 101.62±1.06 | 192  | 37.02 <sup>e</sup> ±0.96 | 35.98 | 101.55 <sup>c</sup> ±0.53 | 7.29 |
| P2                      | 96  | 41.03±1.05               | 101.83±1.07 | 47.04±2.01               | 102.05±1.07 | 192  | 44.04 <sup>f</sup> ±1.23 | 35.68 | 101.97 <sup>e</sup> ±0.53 | 7.30 |
| P3                      | 96  | 40.00±1.05               | 102.04±1.06 | 48.04±2.08               | 102.41±1.07 | 192  | 44.22 <sup>f</sup> ±1.18 | 37.06 | 102.23 <sup>a</sup> ±0.54 | 7.31 |
| Post-work               |     |                          |             |                          |             |      |                          |       |                           |      |
| PW10                    | 96  | 32.15±0.80               | 101.69±1.06 | 37.30±1.39               | 102.05±1.06 | 192  | 34.72 <sup>d</sup> ±0.80 | 32.23 | 101.87 <sup>d</sup> ±0.53 | 7.30 |
| PW20                    | 96  | 26.76±0.57               | 101.38±1.06 | 30.18±1.03               | 101.74±1.06 | 192  | 28.04 <sup>c</sup> ±0.58 | 28.44 | 101.56 <sup>c</sup> ±0.53 | 7.28 |
| PW30                    | 96  | 22.71±0.40               | 101.17±0.98 | 25.03±0.74               | 101.48±0.89 | 192  | 23.87 <sup>b</sup> ±0.41 | 23.84 | 101.32 <sup>b</sup> ±0.53 | 7.28 |
| Overall                 | 672 | 31.20 <sup>a</sup> ±0.39 | 101.50±0.03 | 35.80 <sup>b</sup> ±0.64 | 101.77±0.03 | 1344 | 33.50±0.38               | 41.71 | 101.63±0.02               | 0.84 |

Means bearing different alphabets within a factor differ significantly. Significant ( $P<0.05/P<0.01$ ): CD values

RR: Breed (B) = 2.29, Season (S) = 5.59, Load (L) = 1.09, Time (T) = 1.55, Period (P) = 1.45, B × S = 1.41, B × L = 1.55, B × T = 1.55, B × P = 2.05.

BT: Breed (B) = NS, Season (S) = 0.33, Load (L) = NS, Time (T) = 0.25, Period (P) = 0.08, B × S = 0.06, B × L = 0.08, B × T = 0.08, B × P = 0.11.

periods in RR (6.5-24.37 vs 14.7-51.99/min) and BT (1.5–2.51 vs 1.2–2.87°F) have been recorded in crossbreds as compared to indigenous bullocks (Upadhyay and Madan 1985, Belsare and Pandey 1992, Kumar *et al.* 1996). With regards to breed×period interaction, the BT increased with advancement in working period but the magnitude of rise over previous period gradually decreased. Overall rise in BT during different periods was higher in crossbreds than in Kankrej (0.68, 0.43, 0.36 vs 0.55, 0.36, 0.21 °F for PI, P2 and P3).

#### *Regain / normalization of physiological responses*

Irrespective of breeds, RR at 3 hours of work was 199.64% of pre-work /resting rate (44.22 vs 22.15 per min). At 10, 20 and 30 min post-work the values were 156.75, 128.53 and 107.77% of pre-work state, respectively. The RR regained to near resting value at 30 min of rest post-work. The BT increased by 1.3°F after 3 hours of work and dropped by 0.36, 0.31 and 0.24°F during rest of every 10 min. Thus, the rates of normalization of RR and BT were nearly half and one-third respectively during first 10 min period and during succeeding 10 min periods, the rates of regain reduced (Table 1).

The crossbreds had 213.15% increase in RR at 3 hour (P3) over PO (being 85.53% in Kankrej), at the same time, they had higher rate of regain in comparison to Kankrej at PW10 (49.04 vs 36.41%), PW20 (31.33 vs 25.00%) and PW30 (22.66 vs 18.79%). Similarly, crossbreds had greater increase of BT at P3 (4.47 vs 1.12°F). During first 10 min post-work the rate of regain in BT was similar in both the breeds (0.35-0.36°F, Table 1), indicating that a rest of 10 min between works to Kankrej and J×K crossbred bullocks would result in same magnitude of decline. During later 10 min, the regain was faster in crossbreds (0.35–0.36°F, than in Kankrej (0.21–0.24°F).

Post 3-hour respiration rates were 35.48 and 52.97/min during winter and summer, respectively. During summer, the rate of regain in terms of per cent PO was lower at PW10 (171.45 vs 139.66 %), PW20 (136.36 vs 119.26 %) and PW30 (110.76 vs 104.31%) than during winter. At corresponding periods, BT remained higher by 1.29, 0.81 and 0.50°F during summer and 0.61, 0.46 and 0.24°F during winter (an overall increase in BT was 0.24°F during summer and 0.89°F during winter).

The rates of regain of RR and BT were double during winter in comparison to those during summer in both the breeds. During 30 min post-work, the RR of Kankrej bullocks during summer and winter and that of crossbreds during winter were at par with pre-work RR; while in crossbreds RR at post 30 min rest was significantly higher than initial RR in summer (28.00 vs 26.49/min). Normalization of BT during winter was greater by 3 times in Kankrej and 1.5 times in crossbreds as compared to summer. In both the breeds, the differences in BT at 30 min of rest and initial value were

greater by 0.21 to 0.24°F during summer than in winter. An increase of greater magnitude in ambient temperature during noon hours of summer could be the reason for such findings. It could be inferred that 30 to 45 min rest after 3 hours of continuous work to Kankrej and Jersey×Kankrej bullocks was sufficient to normalize the physiological responses. Haryana bullocks within half an hour (Singh *et al.* 1968) and crossbred bullocks in 1½ to 2 hours following 2 to 4 hours of work (Maurya and Devadattam 1982, Kumar *et al.* 1996) could normalize these responses.

#### *Behavioural distress symptoms and distress score*

All the Kankrej bullocks engaged to different loads during summer only and crossbreds during winter also exhibited nil to scanty salivary discharges. During summer, 16.67% of crossbred bullocks showed scanty salivation, 50.0% exhibited moderate salivation and 33.33% showed profuse salivation or full mouth frothing. Average time taken for salivation reduced from 51.67 min for L1 to half for L4 (25.0 min) post-onset of work. The mean post work-onset time of timing into profuse salivation / full-mouth frothing was only 38-56 min for L4 and 71-83 min for L3. The findings of Upadhyay and Madan (1987) with respect to fatigue in crossbred bullocks during hot-dry and hot-humid seasons, even at two hours of carting 10q. load supported the present results.

Slight excitement with stamping of feet, head shaking and attempt to give up yoke by lowering head or sit down while carting were observed after 162.67±3.18 min of carting L4 and 173.33±2.34 min carting L1 in 33.33% of crossbreds. Opening of mouth with tongue fully protruded out was observed in 1 (16.66%) bullock. These results could be attributed to differences in skin and sweat gland characteristics, body surface area and sweating rate resulting in 4.55 to 17.48% lower heat tolerance of J×K crossbreds in comparison to Kankrej (Patel 1984). The excessive head load in crossbred bullocks might have led them to show temperamental changes while carting heavy loads during summer (THI > 88).

The load unit L4 (total cart load 300 % of body weight, pay load being 1180 kg) particularly during summer could be a heavy work as it caused greatest distress to the bullocks. The distress score on 40-point scale after 3 hours of carting a payload of 1180 kg during stressful period (THI: 88.2) was almost similar for the bullocks of Kankrej (17.08±0.47) and J×K crossbreds (18.17±0.93) and is in favour of crossbred bullocks with respect to their work ability. It ranged from 16 to 20 in Kankrej and 14 to 23 in crossbred bullocks. Upadhyay and Madan (1985, 1987) recorded a fatigue score of 33-27 at 2 hours in crossbreds and 20-22 at 3 h in Haryana. Thus, Kankrej had 2-4 score less than Haryana and J×K crossbreds scored 4-8 points less than HF×Haryana projecting little better thermoregulatory mechanism.

## SUMMARY

A total of 192 carting trials were conducted on 12 bullocks, 6 each of Kankrej and Jersey×Kankrej breed, with 4 carting loads; total cart load equivalent to 150, 200, 250 and 300 % of bullock's weight, for three hours each in morning and afternoon sessions of stressful (THI:  $88.15 \pm 0.70$ ) and comfort (THI:  $74.04 \pm 0.41$ ) seasons on kutchra farm road using single animal pneumatic-tyred cart. Overall respiration rate (RR/min) and rectal temperature (BT°F) of the bullocks were 31.20 and 101.50 in Kankrej and 35.80 and 101.77 in crossbreds. The RR differed significantly ( $P < 0.01$ ) between breeds, but not the BT. Load imposed on the bullocks did affect RR but not BT. The increase in RR and BT were found to be maximum in first hour (+14.87, +0.62) followed by those during second hour (+7.02, +0.42) and minimum during third hour (+0.18, +0.26). The RR and BT were 2.68/min and 0.33°F higher ( $P < 0.01$ ) during afternoon over morning session (32.16/min, 101.47°F). The RR regained to near resting at 30 min after work. The BT dropped 0.36, 0.31, and 0.24°F during rest of every 10 min. The rates of regain of RR and BT were double during winter in comparison to those in summer in both the breeds. During 30 min post-work, the RR of Kankrej during summer and winter and that of crossbreds during winter were at par with pre-work RR; while in crossbreds RR at post 30 min rest was significantly higher than initial RR in summer (28.00 vs 26.49/min). All the Kankrej bullocks engaged to different loads during summer only and crossbreds during winter also exhibited nil to scanty salivary discharges. During summer, 16.67% of crossbred bullocks were found to show scanty salivation,

50.0 % exhibited moderate salivation and 33.33 % showed profuse salivation. The mean distress score on 40 point scale after 3 hours of carting a pay load of 1180 kg during stressful period (THI:88.2) was almost similar (17-18) for bullocks of both the breeds.

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