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Effect of Genetic Group, Season, Their Interaction, Temperature, Humidity and Temperature-Humidity Index on Maintenance Behavior of Stud Bulls

Research Article

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ABSTRACT

Stud bull plays an important role in the development of animal husbandry. Detailed knowledge about maintenance behavior of stud bulls is essential for practicing better management conditions in the farm to support the artificial insemination (AI) industry demand. Therefore, a comparative study was conducted on stud bulls to evaluate the effect of genetic group, season, genetic group × season interaction, temperature, humidity and temperature humidity index (THI) on maintenance behavior. Twenty five stud bulls (five bulls each from five different genetic groups) in two seasons (i.e. winter and summer) maintained at the Frozen Semen Bull Station, Nadia, Haringhata (West Bengal), India were selected for the study. There was a significant effect of genetic group on eating ($P<0.05$), sitting ($P<0.01$), lying ($P<0.01$) and sleeping time ($P<0.01$), season on rumination ($P<0.05$) and sitting time ($P<0.01$), genetic group × season interaction on lying ($P<0.01$) and sleeping time ($P<0.01$), air temperature on drinking ($P<0.05$) and sleeping time ($P<0.05$), humidity on eating ($P<0.01$), rumination ($P<0.01$), sitting ($P<0.01$) and lying time ($P<0.01$) and THI on eating ($P<0.05$) and drinking time ($P<0.05$). There was no effect of genetic group, season, genetic group × season interaction, temperature, humidity and temperature humidity index on standing time. Different genetic groups responded differently in expression of different subcomponents of maintenance behavior in two seasons.

KEY WORDS genetic group, maintenance behavior, season, stud bulls.

INTRODUCTION

Stud bull plays an important role in the development of animal husbandry. Animal husbandry is often affected by various factors, which has negative impact especially on animal welfare, health, and production (Strmenova *et al.* 2013). The focus should be on maintenance behavior that indicates a problem in the herd, if proper management is not done in the farm. Stud bulls play a unique role in cattle breeding. Knowledge of maintenance behavior of stud bulls can markedly improve the efficiency and profitability, quality of life of producers and their animals and integrity of the environment (Iraola *et al.* 2013). Sometimes it appears to be closely related to adverse situation, where animals are frustrated or restricted, while in other cases does not occur, or persists even when the environment is improved (Apple by and Hughes, 1997). A well-balanced proportion of behaviors for cattle can be assumed by making comparisons of time budget of behaviors and activity pattern between various rearing conditions (Brouček *et al.* 2012). Broom (1996) described a variety of behaviors expressed as one measure in a list of good animal welfare indicators. There are some basic behavior components those could be considered as maintenance behavior. They are feeding, drinking, ruminating and resting behavior (Mitlohner *et al.* 2001).

Feeding behavior is an example of important topic for those who have to manage animals, because it has a direct effect on growth and fertility (Fraser and Broom, 1990). The initiation of feeding behavior may be effected by diurnal rhythms and social factors. It varies according to genetic group, species and season. A lot of variation can be seen in the feeding activity of cattle and buffalo regarding the quality of the food. It can be adversely affected by climatic condition, food quality, predators and insects (Kilgour and Dalto 1984). So, proper management and providing sufficient diet can reduce health problem and physiological stress which is important for the welfare of the animal (Shahhosseini, 2013). Management regarding drinking is important because drinking compensates loss of water from the body which occurs via urine, feces, and through sweating; and by evaporation from body surfaces and the respiratory tract. Water is necessary for maintaining body fluids and proper ion balance; digesting, absorbing, and metabolizing nutrients; eliminating waste material and excess heat from the body and transporting nutrients to and from body tissues. Animals get the water they need by drinking and consuming feed that contains water, as well as from metabolic water produced by the oxidation of organic nutrients. The factors affecting drinking are dry matter intake, (Holter and Urban, 1992), temperature, rainfall, humidity, sunlight (Murphy *et al.* 1983) and water temperature (Andersson *et al.* 1984). The amount of water a bull drinks depends on her size, water quality, availability of the water, and amount of moisture in their feed. Rumination can provide an early and more sensitive indication of an animal's health and wellness by maintaining physiological mechanism of the body. Duration of rumination is primarily determined by the composition and quality of feed (Lindstrom *et al.* 2001). It varies according to health, age and body weight of the animal (Acatincai *et al.* 2010).

Seasonal variation is also observed in relation to temperature and feed (Hasegawa and Hidari, 2001). So, proper management should be provided to the bulls to maintain their natural behavior. Rest is vital to animal in its integration and mediation with its environment. It comprises various postures like sitting, standing, lying and sleeping (Mounaix *et al.* 2007). It is directly affected by the management practices because it reflects the comfort of the animal. It varies according to health, age, genetic group, animal species and seasons.

Stud bulls are the animals of high genetic potential. It brings revolution in the AI industry and in the genetic improvement of animals. The climate in a certain geographical area, particularly temperature and relative humidity greatly influence the reproductive potential of the bulls. In the changing climate the genetic groups possibly shows alteration in their normal behavior. Every day, it is like a challenge for the farm managers to maintain the bulls for the best performance under changing climate. But proper management can help the animal to perform better in the tropical area (Hansen, 2004) by maintaining their normal behavior. Therefore, the present experiment was designed to test the hypotheses that the maintenance behavior of stud bulls are influenced by genetic groups, season and interaction between genetic groups × season as well as temperature, humidity and temperature - humidity index for finding out the better managemental practices that could be adopted in the farm for exhibiting better performances by the bulls regarding maintenance activities.

MATERIALS AND METHODS

Experimental animals and management

The study was conducted on 25 stud bulls from five genetic groups (viz., Sahiwal, Gir, Holstein cross, Jersey cross and Murrah Buffalo) maintained at the Frozen Semen Bull Station, Haringhata Farm, Nadia (West Bengal). Five bulls from each genetic group were selected giving emphasis on similar body weight (within genetic group) and age as much as possible. Animals were maintained as per routine management practices of Frozen Semen Bull Station in a uniform environment with identical conditions. They were housed in asbestos roof byre with a concrete floor and pucca walls. Each animal was placed in an individual stall with sufficient ventilation and natural light.

Seasons of observation

The observations were recorded in two seasons, viz., winter, (from 15th January to 15th February, 2014) and summer (5th May to 5th June, 2014). Ten sets of observation on each bull were recorded in each season. Total 50 observations on each genetic group were recorded in each season. Thus, a total of 250 observations in each parameter were recorded in each season.

Meteorological observation

Meteorological data pertaining to both experimental seasons were collected from the Observatory managed by the Bidhan Chandra Krishi Vishwavidyalaya, Mohanpur, Nadia. The Observatory is located within a 1.0 km radius of the bull station. Temperature humidity index (THI) (morning and afternoon) were calculated using:

$$THI= 0.72 (Cdb+Cwb) + 40.6$$

Where:
Cdb and Cwb= dry and wet bulb temperature in centigrade respectively (NRC, 2001).

Average value of meteorological data (temperature, humidity and THI) during two experimental seasons have been presented in Table 1.

Hourly scan sampling (Mialon *et al.* 2008) was used for assessing the maintenance behavior described in Table 2. Observations was recorded for 2 h each morning (09:00 to 11:00 h) and afternoon (14:30 to 16:30 h) starting from 30 min. prior to offering of feed and continued for 1.5 h after offering feed. Each bulls were observed for 2 min. and incidence of behavior(s) was marked on a record sheet suitably tabulated for the purpose. The bull(s) was again observed after 10 min. after completing observation on other bulls in same manner. Total feeding, drinking, ruminating and resting in 48 min/bull were calculated during winter and summer seasons, respectively.

Statistical analysis

To determine the effect of genetic factors like bull and non genetic factor like season on maintenance behavior of stud bulls, mixed model least square and maximum likelihood, PC-2 version computer programme (Harvey, 1975) was applied. The model included the fixed effect of genetic group of animal (5 levels) and season (2 levels) of sampling. The random effect of genetic group was also included in the model. Temperature, humidity and Temperature - Humidity Index was fitted as a linear covariate in the model. The mathematical model used to study the effect of different factors was as follows:

$$Y_{ijk}= \mu + B_i + S_j + (BS)_{ij} + b_1(X_{ijk} - \bar{X}) + b_2(X_{ijk} - \bar{X}) + b_3(X_{ijk} - \bar{X}) + e_{ijk}$$

Where:
Y_{ijk}: record for the k^{th} animal.
μ: overall mean.
B_i: random effect of the i^{th} genetic group (i=5 genetic group i.e. Sahiwal, Gir, Jersey cross, Holstein Friesian (HF) cross, Murrah).
S_j: fixed effect of the j^{th} season of sampling (j=2 season i.e. winter and summer).
$(BS)_{ij}$: interaction effect of the genetic group of animal and season of sampling.
b_1: linear regression coefficient for temperature during sampling.
b_2: linear regression coefficient for humidity during sampling.
b_3: linear regression coefficient for temperature humidity index (THI) during sampling.
X_{ijk}: temperature, humidity and THI, respectively corresponding to Y_{ijk}.
X: arithmetic mean of temperature, humidity THI, respectively, during sampling.
e_{ijk}: residual error element with standard assumptions.

To see the effect of genetic group, season and their interaction, two way analysis of variance (ANOVA) along with Duncan's multiple range test (DMRT) (Steel *et al.* 1997) were performed on various maintenance behavioral parameters. The means, standard deviation, standard error and coefficient of variation of the traits were estimated by using standard statistical procedure given by Snedecor and Cochran, (1967). The result were considered significant if the associated P-value was < 0.05.

RESULTS AND DISCUSSION

Optimum feeding of stud bulls is essential because it influences the lifetime production of animal (Fraser and Broom, 2002). Genetic group (P<0.01), humidity (P<0.01) and THI (P<0.05) were significant on the time spent eating (Table 3). Whereas, there was no effect of seasons, genetic group × season interaction and temperature on eating time (Table 3). During 48 min. of observation the total time spent eating varied from 55.83% to 64.27% (Figure 1). Lower values than those of the presented findings have been reported in cattle (Singh *et al.* 1985) and buffaloes (Jana *et al.* 1988; Yadav and Gupta, 1985). Significant differences in eating time were found between Sahiwal and Gir, Gir and Murrah, Jersey cross and HF cross and Jersey cross and Murrah bulls (P<0.01) (Table 4). Genetic groups influenced the time spent in eating by the stud bulls 4 in the order i.e., Gir > Jersey cross > Sahiwal > Murrah > HF cross.

Only the effects of air temperature (P<0.05) and THI (P<0.05) were observed on drinking time (Table 3). The rest of the effects had no influence on the duration of drinking under different seasons (Table 3). But Fraser and Broom (2002) observed significant variation in drinking time between genetic groups and seasons whereas present findings have been supported by earlier workers (Baumont *et al.* 2006). These observed differences might be due to variation in adaptability of the bulls and management practices of the farm.

Rumination time was effected by season (P<0.05) and humidity (P<0.05) as well as THI (P<0.01) (Table 3). It remained more or less same in all the genetic groups but it declined significantly during the winter compared to summer, which could be due to variation in adaptability during the respective season. Therefore, rumination time was higher in summer than winter.

Table 1 Meteorological data of two experimental seasons (Mean±SE)

Seasons	Max. Temp.	Min. Temp.	Av. Temp.	Max. Hum.	Min. Hum.	Av. Hum.	Max. THI	Min. THI	Av. THI
Winter	25.42±0.50	11.72±0.45	18.57±0.40	94.64±0.72	57.73±2.60	76.18±1.32	60.78±0.92	71.21±0.60	66.00±0.65
Summer	34.65±0.74	25.96±0.35	30.31±0.46	90.18±0.98	60.21±3.33	83.39±2.02	80.66±0.40	85.24±0.73	81.28±1.21

Table 2 Behavioral events used to assess the maintenance behavior

Feeding time	Time when the animals were actively engaged in the ingestion (prehension and swallowing) of concentrate and green fodders
Drinking time	Time spent mouth/muzzle in the water trough for drinking water
Ruminating time:	Time spent either standing or sitting when observed chewing its cud
Resting behaviors (sitting, standing, lying and sleeping)	
Sitting time	Time spent in sitting posture and not performing any other activity
Standing time	Animals remain idle in a standing posture and were not performing any other activity
Lying time	Animals remain idle in a lying posture and were not performing any other activity
Sleeping time	Time spent in sitting or lying posture with closed eyes

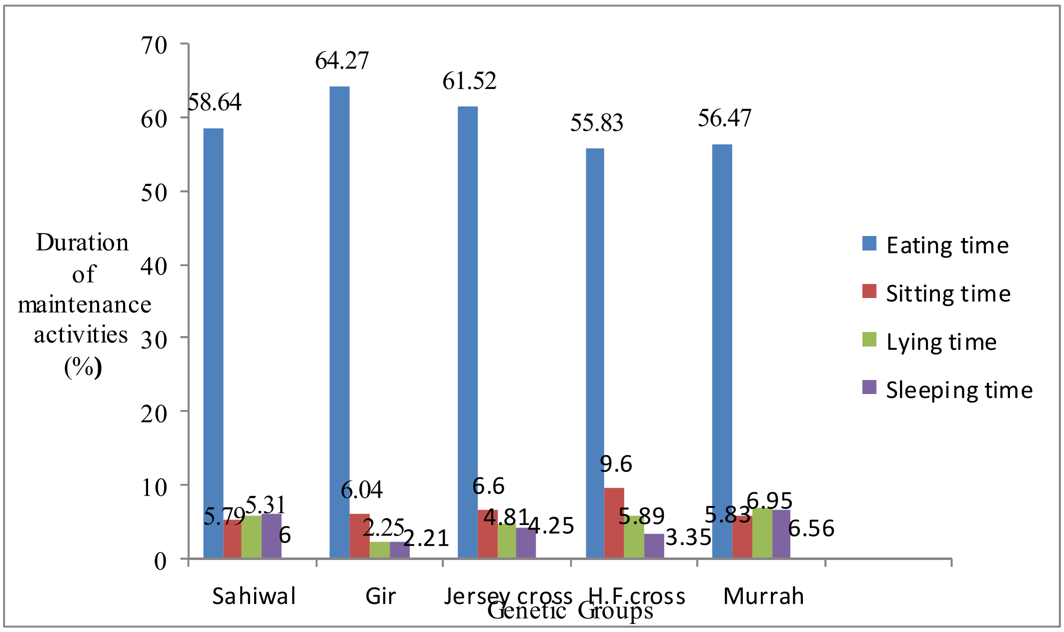

Figure 1 Effect of genetic groups on duration of various maintenance activities (%)

This may due to the fact that during summer, high temperatures may have led to the installing of heat stress, and by this manner the animals were trying to thermo regulate their body temperatures (Acatincai *et al.* 2010). The reference is limited in the literature on the time spent ruminating by stud bulls.

However, the findings of the present study is supported by the findings of Schake and Riggs (1969) in Sahiwal cattle. Seasonal variation can also be observed due to variation in quality of roughage offered to the bulls in different seasons and direct effect of environmental temperature on rumen physiology.

Genetic group (P<0.01), season (P<0.01) and humidity (P<0.01) effect were detected on time spent sitting (Table 3). The rest of the effects (genetic group×season, temperature and THI) had no differences on the behavior (Table 3).

Significant differences in sitting time were found between Sahiwal and HF cross Jersey cross and Sahiwal, HF cross and Murrah and Jersey cross and Murrah (P<0.01) (Table 4). Time spent resting was higher during summer (Table 1).

A higher value (8%) than the present findings was reported by Rusev and Ignatov (1989) in Black pied cows during summer. During 48 min. of observation the total time spent sitting varied from 5.31% to 9.6% (Figure 1). Variation in adaptability of the genetic group(s) to local weather might influence time spent in sitting under the shed. Yadav and Gupta (1985) reported higher values (10%) than that of the present result on sitting time of stud bulls in buffaloes. No differences between genetic groups, seasons, genetic group × season, temperature, humidity and THI were found for standing time (P>0.05) (Table 3).

Table 3 The effects of genetic groups, seasons, their interaction, temperature, humidity and temperature humidity index (THI) on maintenance behavior of stud bulls

Variables (min.)	**P-value**					
	Genetic groups	Seasons	Interaction (genetic group×season)	Temperature (°C)	Humidity (%)	THI
Eating time	0.0026**	0.1055	0.3241	0.8594	0.0004**	0.0240*
Drinking time	0.7756	0.1494	0.4696	0.0494*	0.8938	0.02913**
Rumination time	0.1281	0.0303*	0.3608	0.1141	0.0025*	0.0420**
Sitting time	0.0085**	0.0021**	0.7846	0.8803	0.0002**	0.2995
Standing time	0.4362	0.7486	0.4903	0.2148	0.2798	0.6164
Lying time	0.0006**	0.1899	0.0002**	0.5384	0.0041*	0.6386
Sleeping time	0.0001**	0.5466	0.0004**	0.0446*	0.2621	0.2560

* (P<0.05) and ** (P<0.01).

Table 4 Maintenance behavior of bull during 48 min. per bull of scan sampling observation (Mean±SE)

Genetic groups	**Season**	**Eating time (min.)**	**Drinking time (min.)**	**Rumination time (min.)**	**Resting time**			
					Sitting time (min.)	**Standing time (min.)**	**Lying time (min.)**	**Sleeping time (min.)**
Sahiwal	Winter	29.4±0.45	1.70±0.11	2.79±0.24	2.02±0.28	6.97±0.50	2.09±0.09^{a}	3.03±0.02
	Summer	26.89±0.45	1.45±0.11	3.34±0.24	3.09±0.28	6.73±0.50	3.46±0.09^{b}	2.73±0.02
	Overall	28.15±0.26^{ACDE}	1.57±0.06	3.06±0.13	2.55±0.16^{ACEF}	6.85±0.28	2.78±0.50^{ABCE}	2.88±0.01^{ABDE}
Gir	Winter	31.83±0.45	1.56±0.11	2.80±0.24	2.41±0.28	7.08±0.50	1.00 ±0.09	1.12±0.02
	Summer	29.87±0.45	1.40±0.11	3.05±0.24	3.40±0.28	7.73±0.50	1.15±0.09	1.00±0.02
	Overall	30.85±0.25^{BFHIK}	1.48±0.06	2.92±0.13	2.90±0.16^{EHKN}	7.40±0.28	1.08±0.05^{DGJM}	1.06±0.01^{DHKN}
Jersey cross	Winter	29.65±0.45	1.71±0.11	2.37±0.24	2.56±0.28	6.89±0.50	2.40±0.09	2.22±0.02^{a}
	Summer	29.4±0.45	1.45±0.11	3.11±0.24	3.78±0.28	6.55±0.50	2.21±0.09	1.00±0.02^{b}
	Overall	29.53±0.25^{CHKLN}	1.58±0.06	2.74±0.13	3.17±0.16^{DGKL}	6.72±0.28	2.31±0.05^{BFKL}	1.61±0.01^{CGKL}
Holstein Friesian cross	Winter	27.87±0.43	1.67±0.11	2.74±0.23	4.37±0.28	7.01±0.49	2.12±0.09^{c}	2.02±0.02
	Summer	25.72±0.43	1.42±0.11	3.58±0.24	4.85±0.28	6.60±0.50	3.54±0.09^{d}	2.06±0.02
	Overall	26.80±0.25^{DGMP}	1.54±0.06	3.16±0.13	4.61±0.16^{BGHI}	6.80±0.28	2.83±0.05^{AFHL}	2.04±0.02^{CAGHI}
Murrah	Winter	26.70±0.45	1.76±0.11	2.32±0.24	2.37±0.28	7.24±0.50	3.35±0.09	4.26 ±0.02^{c}
	Summer	27.51±0.45	1.29±0.11	3.28±0.24	3.85±0.28	6.52±0.50	3.32±0.09	2.03±0.02^{d}
	Overall	27.11±0.25^{EJOP}	1.52±0.06	2.80±0.13	2.80±0.16^{FJMN}	6.88±0.28	3.34±0.05^{EILN}	3.15±0.01^{FJMO}

Capital letters the means within the same column with different letter, are significantly different (P<0.01).
Small letters the means within the same column with different letter, are significantly different (P<0.05).

In contrast Gonyou and Stricklin (1981) found that seasonal changes had significant effect on standing time of stud bulls, might be due to management condition of the shed.

Effects of genetic group (P<0.01), genetic group × season interaction (P<0.01) and humidity (P<0.01) on lying time were observed significantly (Table 3). Differences in mean lying time between Gir and Sahiwal, HF cross and Gir, Jersey cross and Gir, Gir and Murrah buffalo were found in the experiment (P<0.01) (Table 4). However Sahiwal bulls spent more time lying during summer in the present study.

Time spent by bulls in lying can depend on the type of housing, comfort of the stall or lying area, type of diet as well as climatic factors (temperature, humidity). When bulls lie down they hold their heads up or drawn back to the flank area. During 48 min. of observation the total time spent lying varied from 2.25% to 6.95% (Figure 1). Higher values (15% and 16%) than that of the present findings were found by Singh *et al.* (1985) in cattle and Thind and Gill (1986) in buffaloes respectively.

There was a significant effect of genetic group (P<0.01) and genetic group × season interaction (P<0.01) and air temperature (P<0.05) on sleeping time (Table 3). Differences in mean sleeping time between Jersey cross and Sahiwal, Murrah and Sahiwal, Murrah and HF cross, Jersey cross and Murrah, Gir and Murrah were found significant (P<0.01) (Table 4).

The mean sleeping time of bulls ranged from 2.21 to 6.56% (Figure 1). Durations of sleeping was higher in Murrah buffalo bulls followed by Sahiwal > Jersey cross > HF cross and Gir in that order. Higher values were observed by Jana *et al.* (1988) in crossbred cattle and Odyuo *et al.* (1995) in buffaloes. Apparently sleeping activity shown by bulls of all genetic groups was more in winter than that during summer season. Present findings were in contrary with the report of Jana *et al.* (1988) and Odyuo *et al.* (1995), who found more sleeping time during summer. This variation could be due to the environmental conditions as sunny day was present during day in the winter which feels more comfortable to the animal.

CONCLUSION

Expression of different subcomponents of maintenance behavior during two seasons (winter and summer) was affected by genetic groups, seasons, genetic group × season, temperature, humidity and THI. Stud bull of different genetic groups showed variation in time spent eating, sitting, lying and sleeping. Effect of season was observed only on rumination and sitting time. Genetic group × season interaction has influenced lying and sleeping time. Temperature of the environment significantly affected drinking and sleeping time. Humidity appeared to have influence on eating, rumination, sitting and lying time. THI showed its affect on eating, drinking and rumination time. Standing behavior appears to be more tolerant to different effects among all components of postural behavior. The differences in the response of maintenance behavior could be observed due to variation in adaptability of the bulls, management practices of farm and environment conditions in two seasons. Therefore, information generated from this study would be very helpful to know the detailed managemental traits of stud bull, which can be maneuvered for day to day management of these animals.

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