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Effect of body weight and scrotal circumference on semen production traits in murrah buffalo bulls

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Artificial insemination is the most commonly used technique to improve the genetic merit of non-descript buffaloes using the frozen semen of genetically superior bulls to augment their production performance. The fertility of breeding bulls is mainly governed by the quantity of semen produced and its quality standards which decide the quality of semen straws for optimum conception rate. Identifying superior germplasm at an early age is of utmost importance for semen stations to maximize the frozen semen doses to meet the demands. The evaluation of bulls breeding soundness would be a vital step for the successful selection of bulls. Body weight and scrotal circumference are the common parameters used in the breeding soundness examination of bulls. Apart from pedigree records, the early selection of bulls for semen stations mainly depends on these parameters for optimal semen production. Moreover, it has been incorporated in the revised physical examination because of its strong correlation with age and sperm production in young bulls. The studies on semen production mainly focus on non-genetic factors like age, seasons, frequencies of collection, etc. (Ramajayan 2016, Bhave *et al*. 2020). However, body weight, scrotal circumference, testicular size, and testicular volume are some of the other factors associated with the quality of seminal traits. Hence, the present study was designed to study the effect of body weight and scrotal circumference on seminal characteristics, which would be useful factors in the selection of breeding bulls.

Seminal traits data from 50,305 and 5,269 ejaculates corresponding to body weight and scrotal circumference, collected from 77 Murrah bulls maintained at Exotic Cattle Breeding Farm, Tamil Nadu, India, were utilized for the study. Body weight data (2007–2015) was collected from the weighment register, and scrotal circumference was measured as per the procedure described by Singh *et al*. (2010). The body weight and scrotal circumference were classified into four groups as <440 kg, 440 to 540 kg, 540 to 640 kg, 640 to 740 kg, and <30 cm, 30 to 33 cm, 33 to 36 cm, and >36 cm, respectively. The effect of factors was analyzed using least-squares analyses under General Linear Model. The means difference was tested by Duncan's multiple range test while traits in percentage are subjected to angular transformation. The correlation coefficients were estimated with Pearson's correlation using SPSS version 20.

The statistical model used for analysis:

$$Y_{ijk} = \mu + B_i + C_j + e_{ijk}$$

where, Y_{ijk}, Semen production trait of k^{th} individual observation belonging to i^{th} body weight and j^{th} scrotal circumference; μ, Overall mean; B_i , Effect of i^{th} body weight (i = 1 to 4); C_j , Effect of j^{th} scrotal circumference (j = 1 to 4); e_{ijk}, Residual random error, normal and independently distributed (Mean 0 and Constant variance σ^2_e).

The overall and least-squares means for the effects of body weight and scrotal circumference on semen characteristics are presented in Tables 1 and 2. Body weight unveiled a highly significant (P<0.01) impact on all the seminal parameters. There was a gradual increase in semen volume as the body weight increased from <440 kg to 640 to 740 kg. The highest value for sperm concentration, total sperm per ejaculate, mass activity, and initial motility was observed in the 640 to 740 kg BW group. Similarly, the highest post-thaw motility (51.81±0.05%) was noticed in the 540 to 640 kg BW group, whereas the lowest value was recorded in the <440 kg BW group. The frozen semen doses per ejaculate gradually increased from 99 to 150 doses, between <440 kg BW and 640 to 740 kg BW groups. In general, bulls weighing 540 kg and above exhibited better semen quality and greater frozen semen doses per ejaculate than those weighing <440 kg. The present results on body weight are consistent with the report of Ravimurugan and Sindhu (2020). These findings suggest that an increase in body weight is indicative of semen production potential and good health status of bulls.

Scrotal circumference evinced a highly significant (P<0.01) effect as a source of variation on all the seminal

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Table 1. Least-squares means (±S.E.) for the effect of body weight on seminal characteristics

Effect	Semen volume (ml)	Sperm concentration (million/ml)	Total sperm per ejaculate (million)	Mass activity (0 to 5 scale)	Initial motility (%)	Post-thaw motility (%)	Frozen semen doses per ejaculate
Overall	2.41±0.01 (50305)	1243.48±4.09 (50305)	2958.27±16.01 (50305)	2.35±0.001 (50305)	62.42±0.13 (50305)	51.10±0.06 (40743)	123.07±0.86 (40743)
Body weight (kg)	**	**	**	**	**	**	* *
<440	2.03^{d}±0.03 (1260)	1248.69^{a}±14.49 (1260)	2517.10^{d}±56.80 (1260)	1.93^{c}±0.03 (1260)	54.76^{d}±0.45 (1260)	48.85^{c}±0.23 (727)	99.25^{d}±3.11 (727)
440 to 540	2.28^{c}±0.01 (8504)	1249.26^{a}±5.78 (8504)	2805.70^{c}±21.86 (8504)	2.30^{b}±0.01 (8504)	60.44^{c}±0.17 (8504)	51.20^{b}±0.08 (5921)	117.29^{c}±1.09 (5921)
540 to 640	2.55^{b}±0.01 (19650)	1206.86^{b}±3.67 (19650)	3005.73^{b}±14.38 (19650)	2.26^{b}±0.01 (19650)	65.04^{b}±0.11 (19650)	51.81^{a}±0.05 (15700)	124.80^{b}±0.67 (15700)
640 to 740	2.78^{a}±0.01 (20891)	1269.13^{a}±3.56 (20891)	3504.55^{a}±13.91 (20891)	2.91^{a}±0.01 (20891)	69.44^{a}±0.11 (20891)	51.57^{a}±0.05 (18395)	150.92^{a}±0.62 (18395)

Means with at least one common superscript within classes do not differ significantly. Figures in parentheses indicate the number of observations. **, Significance level (P<0.01).

Table 2. Least-squares means (±S.E.) for the effect of scrotal circumference on seminal parameters

Effect	Semen volume (ml)	Sperm concentration (million/ml)	Total sperm per ejaculate (million)	Mass activity (0 to 5 scale)	Initial motility (%)	Post-thaw motility (%)	Frozen semen doses per ejaculate
Overall	3.01±0.02 (5269)	1351.83±8.81 (5269)	3998.94±36.20 (5269)	3.73±0.01 (5269)	76.02±0.12 (5269)	52.02±0.08 (5164)	181.94±1.64 (5164)
Scrotal circumference (cm)	**	**	**	**	**	**	**
<30	2.72^{c}±0.04 (776)	1210.68^{c}±20.27 (776)	3143.68^{d}±83.35 (776)	3.64^{c}±0.02 (776)	75.19^{b}±0.29 (776)	51.93^{b}±0.18 (761)	144.82^{d}±3.77 (761)
30 to 33	2.74^{c}±0.03 (1390)	1472.74^{a}±15.15 (1390)	3941.96^{c}±62.28 (1390)	3.71^{b}±0.02 (1390)	76.06^{a}±0.21 (1390)	52.41^{a}±0.13 (1359)	179.98^{c}±2.82 (1359)
33 to 36	3.11^{b}±0.02 (2422)	1351.71^{b}±11.48 (2422)	4162.90^{b}±47.18 (2422)	3.76^{ab}±0.01 (2422)	76.22^{a}±0.16 (2422)	52.47^{a}±0.10 (2377)	189.82^{b}±2.13 (2377)
> 36	3.49^{a}±0.05 (681)	1372.21^{b}±21.64 (681)	4747.23^{a}±88.97 (681)	3.79^{a}±0.02 (681)	76.61^{a}±0.30 (681)	51.27^{c}±0.19 (667)	213.15^{a}±4.02 (667)

Means with at least one common superscript within classes do not differ significantly. Figures in parentheses indicate the number of observations. **, Significance level (P<0.01).

traits. Semen volume, total sperm per ejaculate, mass activity, initial motility, and frozen semen doses per ejaculate displayed an increasing pattern as increase in scrotal circumference with the highest values in 33 to 36 cm and >36 cm groups, respectively. The highest sperm concentration was observed in the 30 to 33 cm group while the lowest in <30 cm group. Likewise, the highest post-thaw motility was spotted in the range of 30 to 36 cm, with the lowest in <30 cm group. The result indicates that bulls with larger scrotal circumference manifested better seminal values and a higher number of frozen semen doses than that of smaller circumferences, which is consistent with the findings of Yadav *et al.* (2019). Testicular size is an important trait that gives an accurate estimate of sperm producing ability of bulls, though it could not be measured directly, scrotal circumference measurements could be used as an accurate estimator for determining the breeding soundness of bulls.

The correlation coefficients of body weight and scrotal circumference on semen production traits are furnished in Table 3. Body weight possessed highly significant positive correlation with scrotal circumference and all seminal parameters, which is on par with Shende *et al.* (2019). Further, scrotal circumference had a highly significant positive correlation with all seminal traits except post-thaw motility, as no correlation was observed. The present outcome on positive correlation of scrotal circumference with seminal characteristics is consistent with Yadav *et al.* (2017) and Yadav *et al.* (2019), but they expressed a non-significant correlation with sperm concentration which is contrary to current findings. The present study revealed that body weight and scrotal circumference are important

Table 3. Correlation coefficient of body weight and scrotal circumference on seminal traits

Trait	Semen volume	Sperm concentration	Total sperm per ejaculate	Mass activity	Initial motility	Post-thaw motility	Frozen semen doses per ejaculate	Body weight
Body weight	0.18**	0.25**	0.16**	0.26**	0.24**	0.20**	0.24**	1.00
Scrotal circumference	0.19**	0.04**	0.18**	0.10**	0.10**	–0.01^{NS}	0.17**	0.19**

**, Significance level (P<0.01); NS, Non-significant.

indicators of seminal quality and frozen semen doses production. It can be concluded that in the selection of young bulls for semen station, higher body weight and scrotal circumference could be considered as crucial parameters of selection.

SUMMARY

The study was undertaken to determine the effect of body weight and scrotal circumference on semen production traits in Murrah buffalo bulls. Data on seminal characteristics, body weight, and scrotal circumference collected from 77 Murrah bulls were utilized to study the effects using least-square analysis under General Linear Model. Body weight and scrotal circumference showed a highly significant impact on all semen production traits. Similarly, the correlation coefficients were also highly significant and positive, except the non-correlation between scrotal circumference and post-thaw motility. An increasing trend in seminal parameters in rise with body weight and scrotal circumference were also observed. Furthermore, bulls weighing 540 kg and above with scrotal circumference of >30 cm displayed better semen quality with higher number of frozen semen doses per ejaculate. These findings suggest that higher body weight and scrotal circumference could be considered as important selection criteria parameters while selecting young bulls for the purpose of frozen semen production to improve the frozen semen doses.

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