

Lunar and Climatic Effects on Boar Ejaculate Traits

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Summary and Implications

The present study was designed to investigate the effects of climatic variables, season of the year and moon phases on boars in Artificial Insemination (AI) centers. The time periods chosen were at the initiation of spermatogenesis and at the moment of collection on boar ejaculate traits. Moon phase had a significant effect ($P < 0.05$) on volume of the ejaculate. Sperm concentration was affected ($P < 0.05$) by the interaction of moon phase with season, high and low temperature, temperature humidity index (THI), relative humidity (RH), and breed. Season had an effect ($P < 0.01$) on concentration of sperm. Number of doses was affected by moon phase, season, the interaction between season and moon phase and breed ($P < 0.05$). An interaction occurred ($P < 0.0001$) between season and moon phase for volume of ejaculate, sperm concentration and number of doses at date of collection and at day of initiation of spermatogenesis.

The significant interaction of season and moon phase on boar semen traits suggests that to maximize productivity of modern swine production systems determining a collection schedule in some seasons relative to moon phase may be advantageous. For example, a collection schedule may be set up to concentrate collections in the fall during last quarter moon phase to maximize the number of doses obtained.

Introduction

There is the belief among wildlife experts that the moon phase influences animal behavior and reproduction. This is supported by scientific evidence that the lunar cycle influences reproduction in several species, including humans, horses and cattle. Season, due to changes in climatic variables, is also an important factor that affects the reproductive performance of boars. Reports in the literature suggest that ejaculate traits differ according to the month of the year, potentially due to differences in both temperature and length of the photoperiod. This is presumably from retention of residual sensory capacities to environmental cues present in wild boars.

Materials and Methods

This study analyzed 4,149 semen collections representing 127 different boars housed at the same boar stud during the period from January 2014 to April 2017. Breeds included Chester White, Berkshire, Duroc, Landrace, Yorkshire, Musclor (French stress negative Pietrain), Gloucestershire Old Spots, Mangalitsa and Meishan.

The response variables included total concentration of sperm, volume of ejaculate, and number of ejaculates. A specific moon phase included the day when the phase was observed and the 2 days before and 2 days after the phase.

Results and Discussion

Results can be seen in Tables 1 and 2 and Figures 1-5. Moon phase had a significant effect on volume of ejaculate at the day of collection ($P < 0.05$). Sperm concentration was affected by the interaction of moon phase with season, high and low temperature, THI, RH and breed ($P < 0.05$). Season had an effect on concentration of sperm at the initiation of spermatogenesis ($P < 0.01$). Number of doses was affected by moon phase, season, the interaction between season and moon phase and breed at collection day and at the initiation of spermatogenesis ($P < 0.05$). There was an interaction between season and moon phase for volume of ejaculate, sperm concentration and number of doses at date of collection and at day of initiation of spermatogenesis ($P < 0.0001$).

When compared between breeds, Yorkshire boars had the greatest value for volume of the ejaculate producing 83 and 93% more semen than the least producing breed at the initiation of spermatogenesis and at day of collection, respectively. Duroc boars had the greatest concentration of sperm/mL in the ejaculate with a mean of 527.33 million sperm and a mean volume of the ejaculate of 161.11 ml, while Yorkshire boars had the least concentration of sperm/mL with an average of 285.07 million sperm while having the greatest ejaculate volume averaging 302.43 ml across both dates studied. Concentrations of sperm/mL of ejaculate in Musclor boars did not differ in the ejaculates compared to Duroc boars.

Conclusions

The significant interaction of season and moon phase on boar semen traits suggests that to maximize productivity of modern swine production systems determining a collection schedule in some seasons relative to moon phase may be advantageous. In particular, while volume of ejaculate from collections in the summer do not

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vary much by moon phase, collection volume is maximized in the winter at the time of the full moon.

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Table 1. Least Squares Means for the different moon phases for volume of the ejaculate, concentration of sperm in the ejaculate and number of doses obtained per ejaculate from 4,149 boars over 3 years from one boar stud.

Moon Phase	Initiation of Spermatogenesis			Day of Collection		
	Volume (ml)	Concentration (x10 ⁶ /ml)	Doses (#)	Volume (ml)	Concentration (x10 ⁶ /ml)	Doses (#)
First ²	235.03±7.46 ^{a1}	372.77±14.14 ^a	19.90±0.62 ^a	238.91±7.83 ^a	378.93±14.44 ^a	19.38±0.62 ^{bc}
Full ³	232.75±7.55 ^a	370.78±14.32 ^a	19.35±0.63 ^{ab}	228.57±7.85 ^b	387.43±14.48 ^a	18.78±0.63 ^c
Last ⁴	231.12±7.54 ^a	378.29±14.29 ^a	19.02±0.63 ^{ab}	239.09±7.86 ^a	389.34±14.51 ^a	20.84±0.63 ^a
New ⁵	226.48±7.48 ^a	386.84±14.18 ^a	18.66±0.63 ^b	234.09±7.97 ^a	378.94±14.73 ^a	20.02±0.64 ^{ab}

¹Different letters across the same column indicate significant differences (P<0.05)

²First quarter moon phase

³Full moon phase

⁴Fast quarter phase

⁵New moon phase

Table 2. Least Squares Means for the different seasons for volume of ejaculate, concentration of sperm in ejaculate, and number of doses obtained per ejaculate from 4,149 boars over 3 years in one boar stud.

Season	Initiation of Spermatogenesis			Day of Collection		
	Volume (ml)	Concentration (x10 ⁶ /ml)	Doses (#)	Volume (ml)	Concentration (x10 ⁶ /ml)	Doses (#)
Spring	229.54±8.42 ^{ab}	381.66±16.10 ^b	18.60±0.71 ^b	239.88±9.36 ^{ab}	360.49±17.46 ^a	18.55±0.76 ^b
Summer	213.90±9.29 ^b	427.80±17.65 ^a	20.91±0.79 ^a	221.87±10.12 ^b	393.63±19.01 ^a	19.96±0.84 ^b
Fall	246.79±10.05 ^{a1}	358.02±19.35 ^{bc}	19.88±0.87 ^{ab}	257.53±11.06 ^a	410.56±20.94 ^a	22.93±0.93 ^a
Winter	235.16±9.22 ^{ab}	341.19±17.71 ^c	17.60±0.79 ^b	221.39±10.12 ^b	369.97±18.99 ^a	17.57±0.84 ^b

¹Different letters within the same column indicate differences (P<0.05)

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Table 3. Results of analysis of variance for effects on volume of the ejaculate, concentration of sperm in the ejaculate and number of doses that could be used for AI obtained per ejaculate from xx boars over xx years.

Effect	DF	Initiation of Spermatogenesis						Day of Collection					
		Volume (ml) ¹		Concentration (x10 ⁶ /ml) ²		Doses (#) ³		Volume(ml)		Concentration (x10 ⁶ /ml)		Doses (#)	
		F Value	P > F	F Value	P > F	F Value	P > F	F Value	P > F	F Value	P > F	F Value	Pr > F
Breed ⁴	6	8.85	<.0001	8.83	<.0001	3.15	0.0066	9.20	<.0001	7.29	<.0001	2.46	0.0279
Season ⁵	3	3.92	0.0083	7.25	<.0001	4.57	0.0034	6.62	0.0002	1.58	0.1924	9.48	<.0001
Moon Phase ⁶	3	1.65	0.1747	1.41	0.2385	4.13	0.0062	4.19	0.0058	0.90	0.4417	9.09	<.0001
HighT	1	1.10	0.2938	8.28	0.004	1.39	0.2390	1.73	0.1886	4.26	0.0391	0.32	0.5706
LowT	1	0.01	0.9382	3.53	0.0603	0.37	0.5447	0.59	0.4420	4.56	0.0328	0.04	0.8442
RH	1	0.91	0.3411	12.10	0.0005	0.08	0.7839	0.47	0.4908	6.79	0.0092	0.01	0.9340
THI	1	1.20	0.2742	13.29	0.0003	0.96	0.3260	3.00	0.0832	8.21	0.0042	0.00	0.9727
season*moon	9	8.44	<.0001	8.77	<.0001	2.37	0.0115	4.15	<.0001	4.81	<.0001	4.16	<.0001

¹Total volume (ml) of ejaculate collected

²Concentration of sperm in the non-diluted ejaculate collected

³Number of doses obtained from the ejaculate

⁴Breed of collected boar

⁵Season of year

⁶Moon phase on the day of collection of semen

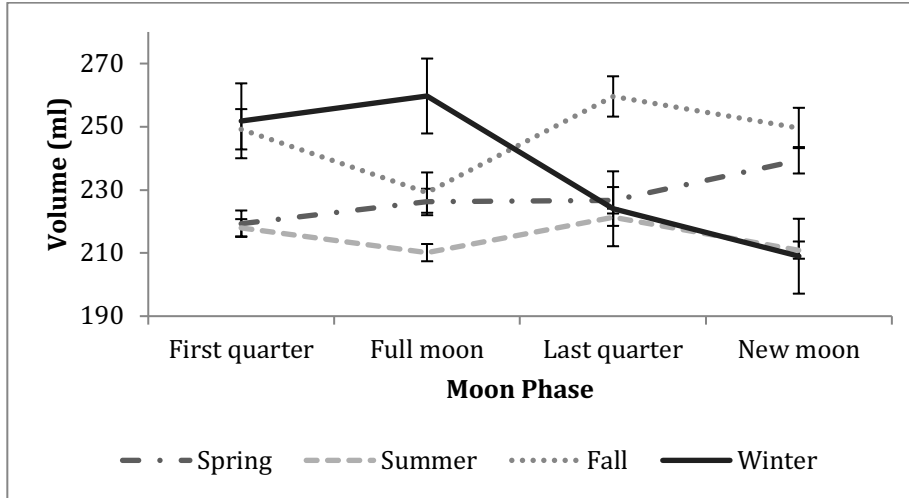


Fig. 1. Interaction plot of season and moon phase at initiation of spermatogenesis for volume of ejaculate (ml). Non-overlapping error bars denote significance.

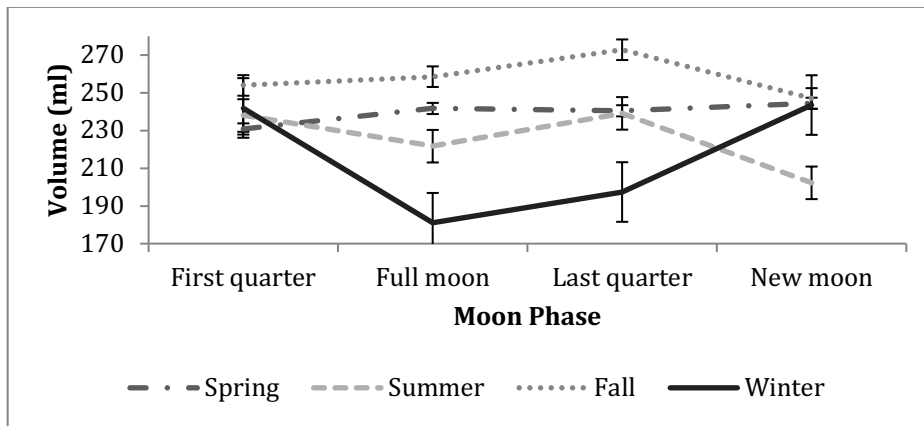


Fig. 2. Interaction plot of season and moon phase at day of collection for volume of ejaculate (ml). Non-overlapping error bars denote significance.

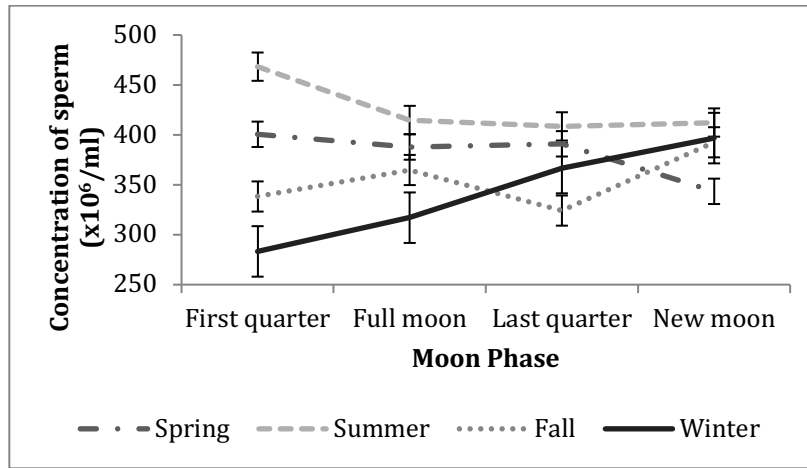


Fig. 3. Interaction plot of season and moon phase at initiation of spermatogenesis for sperm concentration per ejaculate ($\times 10^6/\text{ml}$). Non-overlapping error bars denote significance.

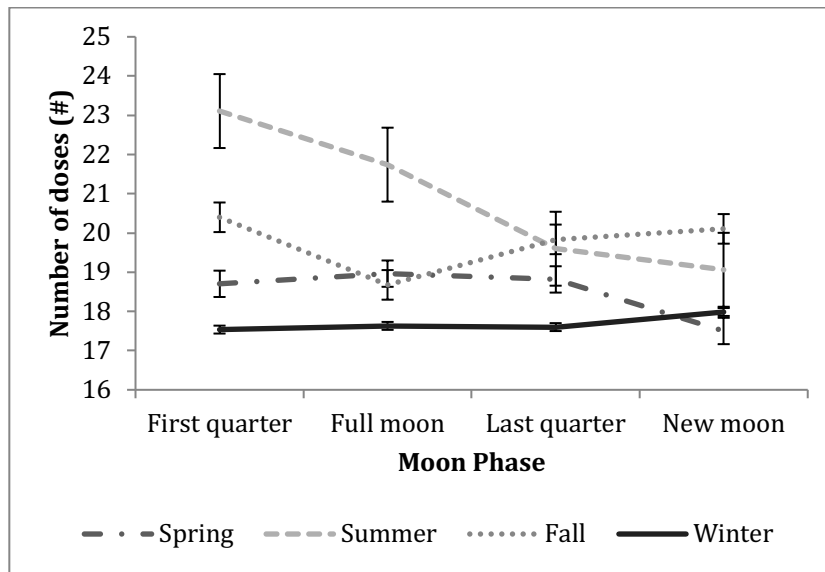


Fig. 4. Interaction plot of season and moon phase at initiation of spermatogenesis date for number of doses obtained per ejaculate (#). Non-overlapping error bars denote significance.

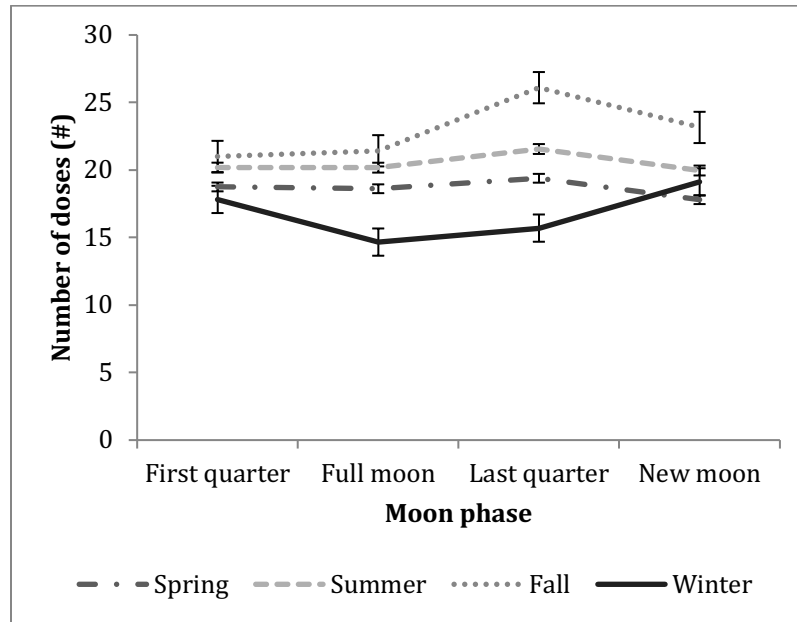


Fig. 5. Interaction plot of season and moon phase at collection date for number of doses obtained per ejaculate (#). Non-overlapping error bars denote significance