

VISUALIZE

Breeding Problems

Infrared thermography offers an avenue to find costly reproductive problems that could otherwise go undetected.

BY SHAUNA ROSE HERMEL

Newscasters have flashed us colorful, infrared images of houses to show us the "hot" spots where heat is escaping through poor insulation. The thermograms let us see trouble areas, possibly otherwise invisible, where our heating dollars are being wasted.

Researchers are using the same technology to illuminate fertility problems in bulls that could otherwise waste our breeding dollars.

Temperature control important

Temperature control — thermoregulation — of the testicles is essential to bull fertility, explains Glenn Coulter, assistant director of commercialization and marketing at the Lethbridge

Research Centre, Lethbridge, Alberta, Canada. For normal sperm production, the testes in the scrotum have to be maintained at a temperature 2-5°C cooler than normal body temperature. Elevated temperatures will have a negative effect on sperm production, semen quality and bull fertility.

Other researchers, he says, have shown that the surface temperature of the scrotum is highly correlated with internal testicular temperature. And infrared thermograms (IRTs) of the scrotal surface can provide accurate insights into thermoregulation.

More insight than BSE

Together with Donald Lunstra at the U.S. Meat Animal

Research Center (MARC) in Clay Center, Neb., Coulter has shown that thermograms can spot problems in bulls declared satisfactory in breeding soundness exams (BSEs).

For their study, Lunstra and Coulter recorded a color video thermogram of the scrotal temperature patterns of 73 yearling beef bulls, all of which had passed a BSE. From the thermograms, they recorded the average scrotal surface temperature, temperatures at the top and the bottom of the scrotum, scrotal temperature gradient and thermal class (normal, questionable or abnormal).

Of those bulls, says Coulter, 37 (51%) had normal temperature patterns, 20 (27%) had questionable temperature

patterns, and 16 (22%) had abnormal temperature patterns.

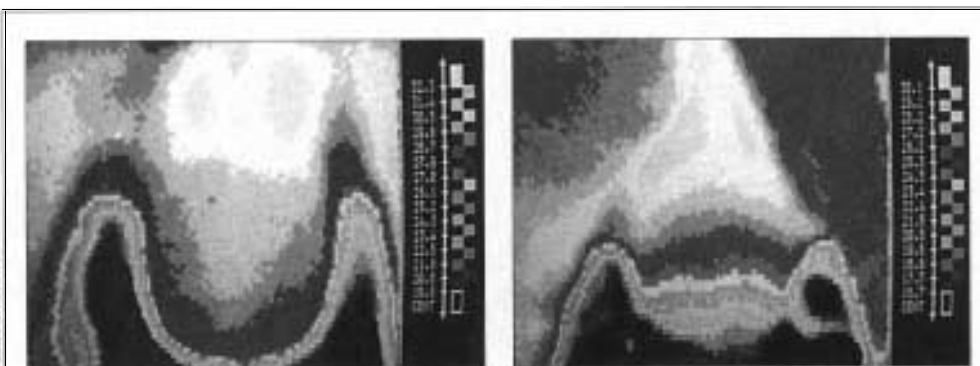
The bulls with abnormal temperature patterns had a significantly lower percentage of

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— Glenn Coulter

sperm with normal head and tail development and a significantly higher percentage of sperm with proximal droplets than bulls with normal or questionable thermograms. These results, says Coulter, add support to the theory reduced semen quality may be related to impaired testicle thermoregulation.

To test fertility in the real world, the researchers exposed 30 of the bulls, including some from each thermal class, to 18 heifers each in a single-sire, natural-mating system. The bulls were allowed a 45-day breeding season. Pregnancy rates were significantly lower for bulls with abnormal scrotal temperature patterns (68%)



"Infrared thermography (IRT) is a relatively new, noninvasive, radiological technique that provides a pictorial image of a viewed object's infrared emissions," explains Canada's Glenn Coulter. "To obtain a pictorial image (thermogram), a scanner converts electromagnetic energy (heat) radiated from an object into electronic video signals," Coulter is using the technology to get a picture of scrotal thermoregulation and insights into bull fertility. Bulls with abnormal thermograms (thermogram on left) will settle fewer cows than bulls with normal thermograms (thermogram on right).

PHOTOS COURTESY LETHBRIDGE RESEARCH CENTRE

than for bulls with normal (83%) or questionable (85%) patterns (see Table 1).

Pregnancy rate, says Coulter, was also significantly related to all four major temperature measures (average surface, top and bottom temperatures; and temperature gradient) based on the thermograms.

“These results provide the first data indicating that beef bulls with abnormal scrotal temperature patterns also exhibit significantly reduced fertility (pregnancy rates) when used in natural mating,” says Coulter. “Infrared thermography shows promise as a tool for predicting fertility in young beef bulls.”

Interesting sidelight

Among the 30 bulls that were fertility tested through natural mating, there was a negative relationship (though not quite strong enough to be counted statistically significant) between testicle size and pregnancy rate. Bulls in the abnormal thermal class, on average, had larger testicles and higher scrotal temperatures than bulls in the normal or questionable thermal categories.

“Although detected only with IRT thermography, abnormal testicular thermoregulation in bulls may possibly be associated with a small increase in testis size,” the researchers note in their research summary published in the *Journal of Animal Science* (75: 767-774).

So what is normal?

A thermogram of a bull with normal scrotal thermoregulation will show horizontal bands across the scrotum, explains Coulter. Each band represents a narrow range in surface temperature. The bands should become progressively cooler as they approach the bottom of the scrotum.

“In terms of abnormal thermograms, we can see anything and everything in terms of temperature,” says Coulter. Some may show hot or



Table 1: Means by scrotal infrared temperature (IRT) thermogram class for scrotal surface temperatures and pasture-mating fertility (single-sire) of 30 yearling beef bulls that had passed a breeding soundness exam

	Scrotal thermogram class ^a		
	Normal	Questionable	Abnormal
No. of bulls	13	9	8
Scrotal thermogram characteristic^b			
Avg. surface temp., °C	26.6 ^c	27.0 ^c	27.8 ^c
Temp. at top, °C	28.0	27.8	28.2
Temp. at bottom, °C	25.0 ^c	26.0	27.3 ^c
Temp. gradient, °C	3.0 ^c	1.8 ^c	0.9 ^c
Fertility^d			
No. females exposed/bull	17.7	18.3	17.3
Pregnancy rate, %	83.4 ^c	85.3	68.3 ^c
Pregnancy rate, range	72-100%	74-100%	38-85

^aAll scrotal surface infrared temperature (IRT) thermogram data were adjusted to a constant ambient temperature (10°C) before analysis. Where means for bulls with abnormal thermograms differ from means of bulls with normal or questionable thermograms, significance of the difference is indicated: ^cP<.05; ^dP<.01.

^dFertility (pregnancy) data for 30 yearling beef bulls were obtained via single-sire, natural-mating tests (approximately 18 heifers/bull, 45-day breeding period) conducted when bulls were approximately 15 months of age.

cold spots, while others may show an asymmetrical temperature pattern. These problems may be associated with pathological conditions such as infections, vascular lesions, duct obstructions, neoplastic disease or autoimmune reactions, he explains.

The difference in scrotal surface temperature from top to bottom, called the temperature gradient by researchers, also seems to have an impact on fertility. In Coulter's research, bulls with temperature gradients between 4-6°C had a lower incidence of primary sperm defects than bulls with gradients less than 4°C.

It's very discouraging to have a bull pass a BSE, then fall short of getting the cows bred. By finding problems not found during a routine BSE, infrared thermography might provide another way to safeguard against delayed calvings and open cows.

“This technology allows us to inspect the thermoregulation, the temperature control mechanisms within the bull,” Coulter says.

To date, the technology has been cost-prohibitive for use at

the commercial level. That may change within the next year or two, says Coulter. The researchers are currently working with a Florida-based company to develop equipment that would be affordable to veterinarians or universities

routinely evaluating a number of bulls.

The Canadian researcher believes IRT will become an important tool in identifying abnormalities that may prevent bulls from getting the job done.

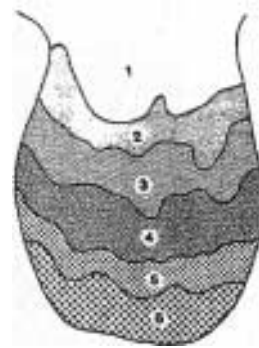


Illustration of an infrared thermogram of the bull scrotum depicting normal thermoregulation. Each horizontal band across the scrotum represents a narrow range in surface temperature. The bands are relatively warm near the body and become progressively cooler as they approach the bottom of the scrotum.



Illustration of an infrared thermogram of the bull scrotum depicting abnormal thermoregulation. Temperature bands lack symmetry from left to right compared to the first example, and an area of elevated temperature (a “hot spot”) is evident over the right testis (temperatures increase as numbers decrease). Coulter says he would expect a bull with this thermogram to have impaired seminal quality.

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