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Environmental Factors Impacting Response to Bovine Viral Diarrhea Vaccines in Angus Calves

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Abstract
Bovine respiratory disease is a very significant disease affecting feedlot cattle across the US. We are interested in investigating the genetic control of response to respiratory disease vaccines as a method of reducing respiratory disease in feedlots in the future. When beginning to investigate genetic control of a new trait, it is important to characterize nongenetic effects on that trait. Therefore, the objective of this study was to evaluate the impact of environmental factors on the serological response to vaccination for a commercial bovine viral diarrhea (BVDV2) vaccine.

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Introduction

Bovine respiratory disease is a very significant disease affecting feedlot cattle across the US. We are interested in investigating the genetic control of response to respiratory disease vaccines as a method of reducing respiratory disease in feedlots in the future. When beginning to investigate genetic control of a new trait, it is important to characterize non-genetic effects on that trait. Therefore, the objective of this study was to evaluate the impact of environmental factors on the serological response to vaccination for a commercial bovine viral diarrhea (BVDV2) vaccine.

Materials and Methods

This study used 353 Angus calves born in spring (n = 176) and fall (n = 177) calving seasons of 2006 from the Iowa State University Angus Breeding Project. Two vaccinations, initial and booster, were administered approximately 3 weeks apart. Blood serum samples were collected at time of initial vaccination, booster vaccination, and approximately 2 weeks after booster vaccination for response to booster. Spring calves were weaned and given initial vaccination at the same time, and the fall calves were weaned at the time of booster vaccination administration.

The level of neutralizing antibodies present in sera was titered via serum neutralization tests using cytopathic BVDV2. Briefly, each serum was serially diluted 1:2 and the highest dilution of serum that was still capable of neutralizing virus was determined. The reciprocal of the average of the highest dilution, which had virus neutralizing activity, was recorded as the serum titer.

Response to initial vaccination was calculated as serum titer at time of booster vaccination minus serum titer at time of initial vaccination. Response to booster vaccination was calculated as serum titer at time of booster response serum draw minus serum titer at time of booster vaccination. Overall response to initial and booster vaccination was calculated as serum titer level at time of booster response serum draw minus serum titer level at time of initial vaccination.

Results and Discussion

Means for age, weight, and titer level at initial vaccination, booster vaccination, and response to booster vaccination serum draw are presented in Table 1 for each calving group. Titer levels at the time of first vaccination were not influenced by gender ($P = 0.13$) but were influenced by calving group (spring or fall) ($P < 0.001$) and calf age ($P < 0.001$). This observation may result from a higher level of maternal antibodies in younger calves.

When evaluating the response to the different vaccinations (initial, booster, and overall initial and booster) we evaluated the significance of class effects of calving season and gender of calf as well as covariates for serum titer level at the time of vaccination, age at the time of vaccination, and weight at the time of vaccination. Significance level for these effects and estimates of the covariate effects are presented in Table 2.

Titer level at the time of vaccination was consistently the most statistically significant effect ($P < 0.001$ for all three response variables) for predicting response to vaccination strategy, with animals having a higher initial titer level experiencing a smaller increase in titer as a result of a vaccination strategy. Other effects tested for statistical significance for prediction of response to vaccination included calving group, gender, age at vaccination, and weight at vaccination. Calving group was the next most statistically significant effect for predicting response to initial vaccination and overall vaccination ($P < 0.001$ and $P < 0.05$, respectively).

LSMeans estimates for the response to initial vaccination were -1.49 and 0.31 for the spring born and fall born groups, respectively. Furthermore, LSMeans estimates for the response to overall vaccination program were 1.52 and 2.21 for spring born and fall born groups, respectively. Therefore, it seems that stress of weaning at the same time as initial vaccination may limit the ability of animals to respond to a vaccine.

Subsequent work on this study has been modified to give initial vaccine preweaning for half of the cattle and initial vaccine at weaning for the other half of the cattle within each of the calving groups.

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Table 1. Means for age, weight, and serum titer level at time of initial vaccination, booster vaccination, and response to booster vaccination for spring and fall born calf groups.

	Spring born	Fall born
Avg. initial vacc. age, d	170	127
Avg. booster vacc. age, d	189	148
Avg. resp. to booster vacc. age, d	203	162
Avg. initial vacc. weight, lb.	400	311
Avg. booster vacc. weight, lb.	438	353
Avg. resp. to booster vacc. weight, lb.	445	402
Avg. initial vacc. titer, 2X dilutions	2.23	5.20
Avg. booster vacc. titer, 2X dilutions	1.42	4.82
Avg. resp. to booster vacc. titer, 2X dilutions	5.38	5.80
Avg. titer resp. to initial vacc., 2X dilutions	-0.81	-0.38
Avg. titer resp. to booster vacc., 2X dilutions	3.96	0.98
Avg. titer resp. to both vacc., 2X dilutions	3.14	0.59

Table 2. Significance and estimates of effects for predicting response to vaccination for initial, booster, or overall vaccination strategy.

	Response to initial vacc., P-value	Response to initial vacc., estimate	Response to booster vacc., P-value	Response to booster vacc., estimate	Overall response to initial and booster vacc., P-value	Overall response to initial and booster vacc., estimate
Full model, R^2		0.295		0.646		0.694
Calving group	<0.001		0.75		<0.05	
Titer at vaccination, 2X dilutions	<0.001	-0.424	<0.001	-0.786	<0.001	-1.109
Gender	<0.01		0.31		0.68	
Age at vaccination, d	<0.10	0.0093	<0.10	0.0112	0.57	0.0039
Weight at vaccination, lb	<0.05	-0.0033	<0.10	-0.0029	0.16	-0.0025