Effects of Excitable Temperament and its Physiological Consequences on Reproductive Performance of Brahman-crossbred Cows

R. F. Cooke[1]
D. B. Araujo
G. C. Lamb
J. D. Arthington

Measurements and physiologic responses associated with cow temperament, acute phase response, and energy status influence the probability of Brahman-crossbred cows to become pregnant during the breeding season

Summary

The objective of this experiment was to evaluate the effects of cow temperament, acute phase response, and energy status on the probability of Brahman-crossbred cows to become pregnant during the breeding season. Over two consecutive yr, 160 Braford and 235 Brahman × British cows were exposed to mature Angus bulls during a 90-d breeding season. Prior to the beginning of breeding, cows were evaluated for body condition score (BCS) and temperament, while blood samples were obtained for determination of plasma concentrations of insulin-like growth factor I (IGF-I), cortisol, ceruloplasmin and haptoglobin. During year 1, probability of pregnancy during the breeding season increased linearly (P<0.05) as temperament score and concentrations of ceruloplasmin, haptoglobin, and cortisol (Braford cows only) decreased, whereas BCS and IGF-I concentrations affected the probability of pregnancy quadratically (P<0.05). During year 2, probability of pregnancy increased linearly (P<0.05) as concentrations of ceruloplasmin and haptoglobin decreased, whereas BCS, temperament score, and concentrations of cortisol and IGF - I affected the probability of pregnancy quadratically (P<0.05). These results suggest that measurements and physiologic responses associated with temperament, health, and energy status influence the probability of cows to become pregnant during the breeding season.

Introduction

The major objective of cow-calf production systems is to produce one calf per cow annually. Ovulation of a competent oocyte determines the length of the postpartum interval and also the fertility of beef cows during the breeding season (Short et al., 1990). Follicle size and LH pulsatility are major factors responsible for a successful ovulation (Roche, 2006); therefore, alternatives to stimulate GnRH delivery to the pituitary, and anticipate/enhance the ovulatory LH surge are options to maximize reproductive performance of beef cows (Day, 1994).

Several factors are known to influence GnRH and gonadotropin synthesis in cattle. Cattle with excitable temperament often experience stimulated secretion and circulating concentrations of ACTH and cortisol (Curley et al., 2008), and these hormones directly impair

synthesis and release of GnRH and gonadotropins (Li and Wagner, 1983; Dobson et al., 2000). Animals under inflammatory processes, such as the acute phase response, may also experience impaired GnRH and gonadotropin production (Peter et al., 1989; Battaglia et al., 2000; Williams et al., 2001). Additionally, energy intake and level of body reserves directly modulate circulating concentrations of IGF-I (Wettemann et al., 2003), which in turn may enhance GnRH and gonadotropin synthesis, and also potentiate the effects of gonadotropins in the ovary (Spicer and Stewart, 1996; Wettemann et al., 2003). Therefore, the objective of this study was to determine the probability of cows to become pregnant during the breeding season, according to BCS, temperament score, and concentrations of IGF-I, cortisol, and acute phase proteins assessed at the beginning of breeding.

Materials and Methods

Over two consecutive years, 160 Braford and 235 Brahman × British cows were evaluated for BCS (emaciated = 1, obese = 9; Wagner et al., 1988) and plasma concentrations of IGF-I, cortisol, ceruloplasmin, and haptoglobin at the beginning of the breeding season. Cows were exposed to mature Angus bulls for 90-d, whereas bull to cow ratio was, respectively, 1:20 for both breed types.

Cow temperament was assessed by pen score, chute score, and exit velocity. Chute score was assessed by a single technician based on a 5-point scale, where 1 = calm, no movement, and 5 = violent and continuous struggling. For pen score assessment, cows exited the chute and entered a pen containing a single technician, and were assigned a score on a 5-point scale, where 1 = unalarmed and unexcited, and 5 = very excited and aggressive toward the technician in a manner that requires evasive action to avoid contact between the technician and cow. Exit velocity was assessed by determining the speed of the cow exiting the squeeze chute by measuring rate of travel over a 1.5-m distance with an infrared sensor (FarmTek Inc., North Wylie, TX). Further, cows were divided in quintiles according to their exit velocity, and assigned a score from 1 to 5 (exit score; 1 = slowest cows; 5 = fastest cows). Individual temperament scores were calculated by averaging cow chute score, pen score, and exit score.

Blood samples were collected via jugular venipuncture into commercial blood collection tubes (Vacutainer, 10 mL; Becton Dickinson, Franklin Lakes, NJ) containing sodium heparin, placed on ice immediately, and centrifuged at 2,400 × g for 30 min for plasma collection. Plasma was frozen at -20°C on the same day of collection. Concentrations of cortisol were determined using a Coat-A-Count solid phase ^{125}I RIA kit (DPC Diagnostic Products Inc., Los Angeles, CA). A double antibody RIA was used to determine concentrations and IGF-I (Badinga et al., 1991; Cooke et al., 2007). Concentrations of ceruloplasmin were determined according to procedures described by Demetriou et al. (1974). Concentrations of haptoglobin were determined by measuring haptoglobin/hemoglobin complex by the estimation of differences in peroxidase activity (Makimura and Suzuki, 1982).

The probability of cows to become pregnant during the breeding season was determined with the GLM and LOGISTIC procedures of SAS. The GLM procedure was utilized to determine if each individual measurement influenced pregnancy rates linearly, quadratically, and/or cubically. If multiple continuous order effects were significant, the effect with the greatest F-value was selected. The LOGISTIC procedure was utilized to determine the intercept and slope(s) values according to maximum likelihood estimates from the significant effect selected, and the probability of pregnancy was determined according to the equation: Probability = $(e^{\text{logistic equation}}) / (1 + e^{\text{logistic equation}})$. Logistic curves were constructed according to the minimum and maximum values detected for each individual measurement.

Results

The probability of cows to become pregnant, according to measurements obtained at the beginning of the breeding season, was evaluated within each year because mean days post-partum across breeds at the onset of breeding differed (P<0.01) from yr 1 to yr 2 (88 vs. 34 d,

respectively; SEM=1.5). Plasma IGF-I concentrations and cow BCS affected quadratically ($P<0.01$) the probability of pregnancy during both yr (Figure 1). These results indicate that reduced or excessive energy status is detrimental to reproductive performance of cattle, as reported by others (Armstrong et al., 2001; Bilby et al., 2006; Cooke et al., 2008b). Cow temperament score and plasma cortisol concentrations affected the probability of pregnancy linearly ($P=0.03$) during yr 1, and quadratically ($P<0.01$) during yr 2 (Figure 2). These results suggest that excitable temperament and consequent elevated cortisol concentrations (Curley et al., 2008) are detrimental to reproductive function of cows. Concurring with our findings, Plasse et al. (1970) reported that excitable temperament influences negatively the reproductive performance of beef females. Additionally, as observed in yr 2, reduced cortisol concentrations and temperament score during the early postpartum period may denote health disorders that negatively affect cattle reproduction, such as lethargy, lameness (Sprecher et al., 1997), and immunosuppresion (Goff, 2006). Plasma concentrations of ceruloplasmin and haptoglobin affected the probability of pregnancy linearly during yr 1 ($P<0.01$ and $=0.04$, respectively) and yr 2 ($P=0.01$; Figure 3), suggesting and supporting previous data indicating that the acute phase response is detrimental to reproductive function of livestock (Peter et al., 1989; Battaglia et al., 2000; Williams et al., 2001).

In conclusion, results from this study indicate that measurements and physiologic responses associated with cow temperament, acute phase response, and energy status influenced the probability of cows to become pregnant during the breeding season. Therefore, management strategies that improve cow disposition, enhance their immune status, and maintain the cowherd at adequate levels of nutrition are required for optimal reproductive performance of Brahman-crossbred cows, and consequent productivity of cow-calf operations containing these types of cattle.

Literature Cited

Armstrong et al. 2001. Biol. Reprod. 64:1624-1632.

Badinga et al. 1991. J. Anim. Sci. 69:1925-1934.

Battaglia et al. 2000. Biol. Reprod. 62:45-53.

Bilby et al. 2006. J. Dairy Sci. 89:3360-3374.

Cooke and Arthington. 2008. Prof. Anim. Sci. 24:264-268.

Cooke et al. 2007. J. Anim. Sci. 85:2564-2574.

Curley et al. 2008. Horm. Behav. 53:20-27.

Day. 2004. Anim. Reprod. Sci. 82-83:487-494.

Demetriou et al. 1974. Clinical Chemistry 857-864

Dobson et al. J. Reprod. Fertil. 120:405-410.

Goff. 2006. J. Dairy Sci. 89:1292-1301.

Li and Wagner. 1983. Biol. Reprod 29:25-37.

Makimura and Suzuki. 1982. Jpn. J. Vet. Sci. 44:15-21.

Peter el al. 1989. Am. J. Vet. Res. 50:368-373.

Plasse et al. 1970. J. Anim. Sci. 30:63-72.

Spicer and Stewart. 1996. Biol. Reprod. 54:255-263.

Sprecher et al. 1997. Theriogenology 47:1179-1187.

Wagner et al. 1988. J. Anim. Sci. 66:603-612.

Wettemann et al. 2003. J. Anim. Sci. 81(E. Suppl. 2):E48-E59.

Williams et al. 2001. Endocrinology 142:1915-1922.

[1]R. F. Cooke, Former Graduate Student; D. B. Araujo, Graduate Student; G. C. Lamb, Associate Professor, UF- IFAS North Florida Research and Education Center, Marianna FL; J. D. Arthington, UF-IFAS Range Cattle Research and Education Center, Ona, FL

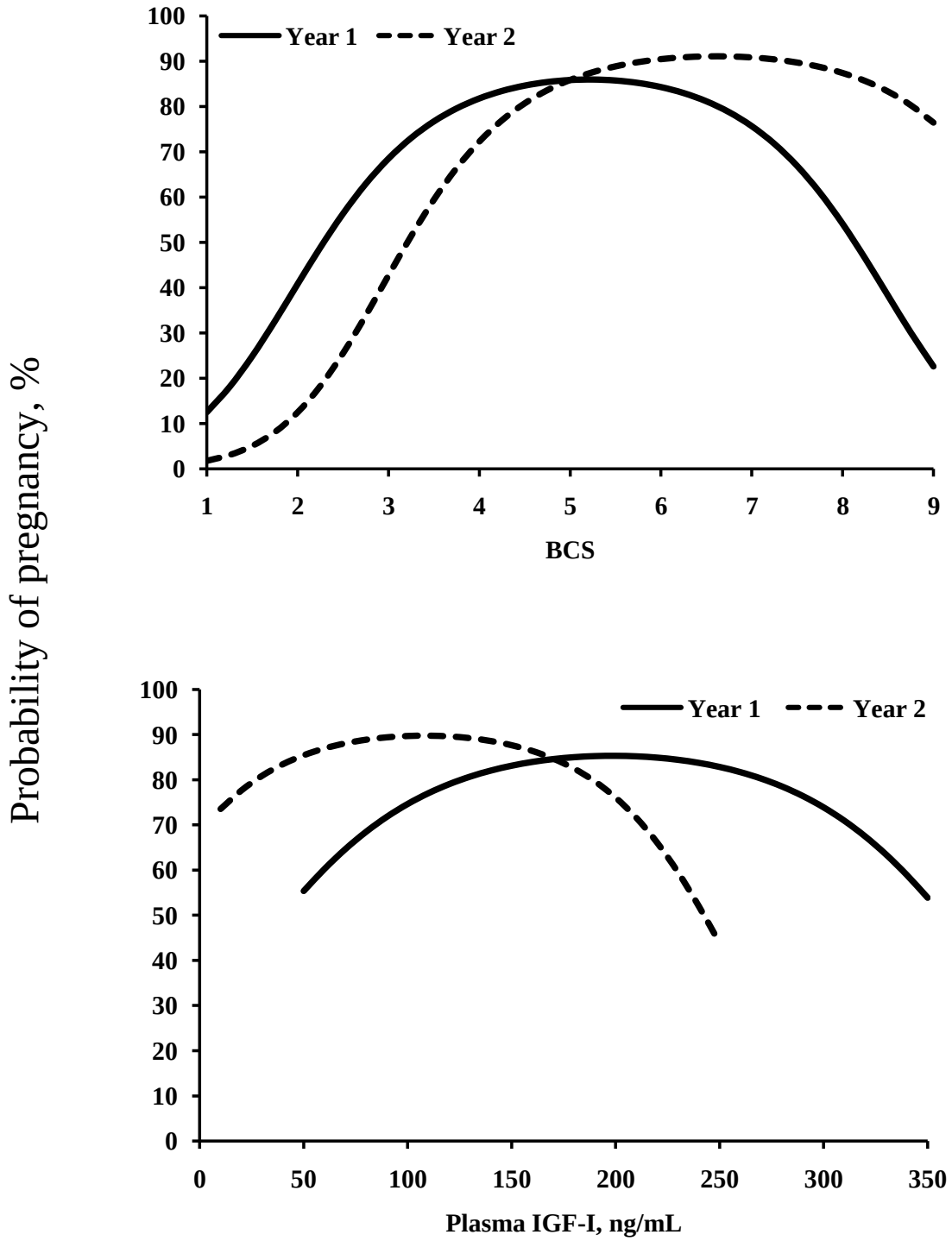

Figure 1. Effects of BCS (emaciated = 1, obese = 9; Wagner et al., 1988) and plasma IGF-I concentrations, assessed at the beginning of the breeding season, on the probability of Brahman-crossbred cows to become pregnant. A quadratic effect was detected during yr 1 and 2 for BCS (P<0.01) and plasma IGF-I (P=0.02 and <0.01, respectively).

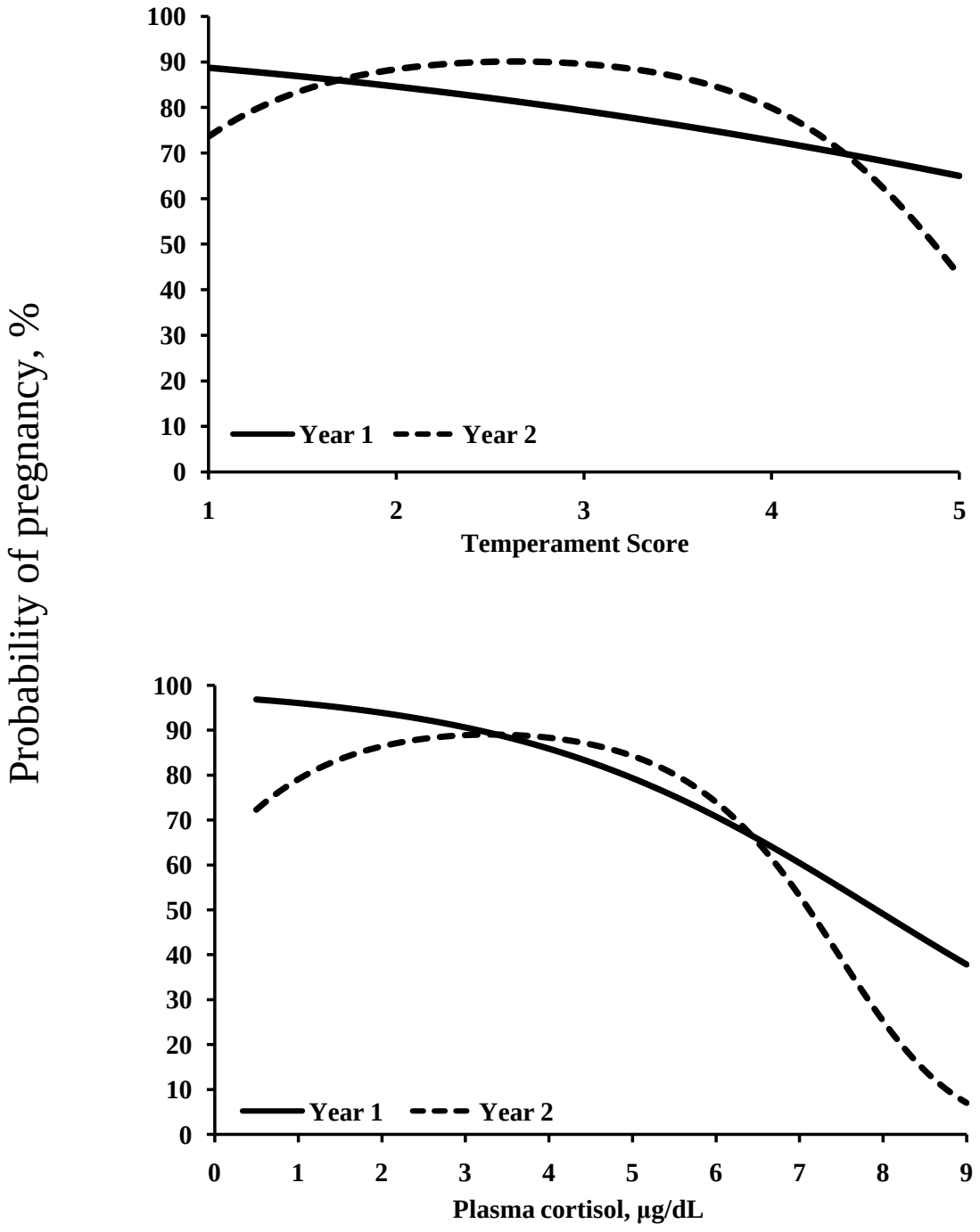

Figure 2 Effects of temperament score and plasma cortisol concentrations, assessed at the beginning of the breeding season, on the probability of Brahman × British and Braford cows to become pregnant. For temperament score, a linear effect (P=0.03) and a quadratic effect (P<0.01) were detected for both breeds during yr 1 and 2, respectively. For plasma cortisol, a linear effect was detected (P=0.04) for Braford cows during yr 1, whereas a quadratic effect was detected (P=0.02) for both breeds during yr 2.

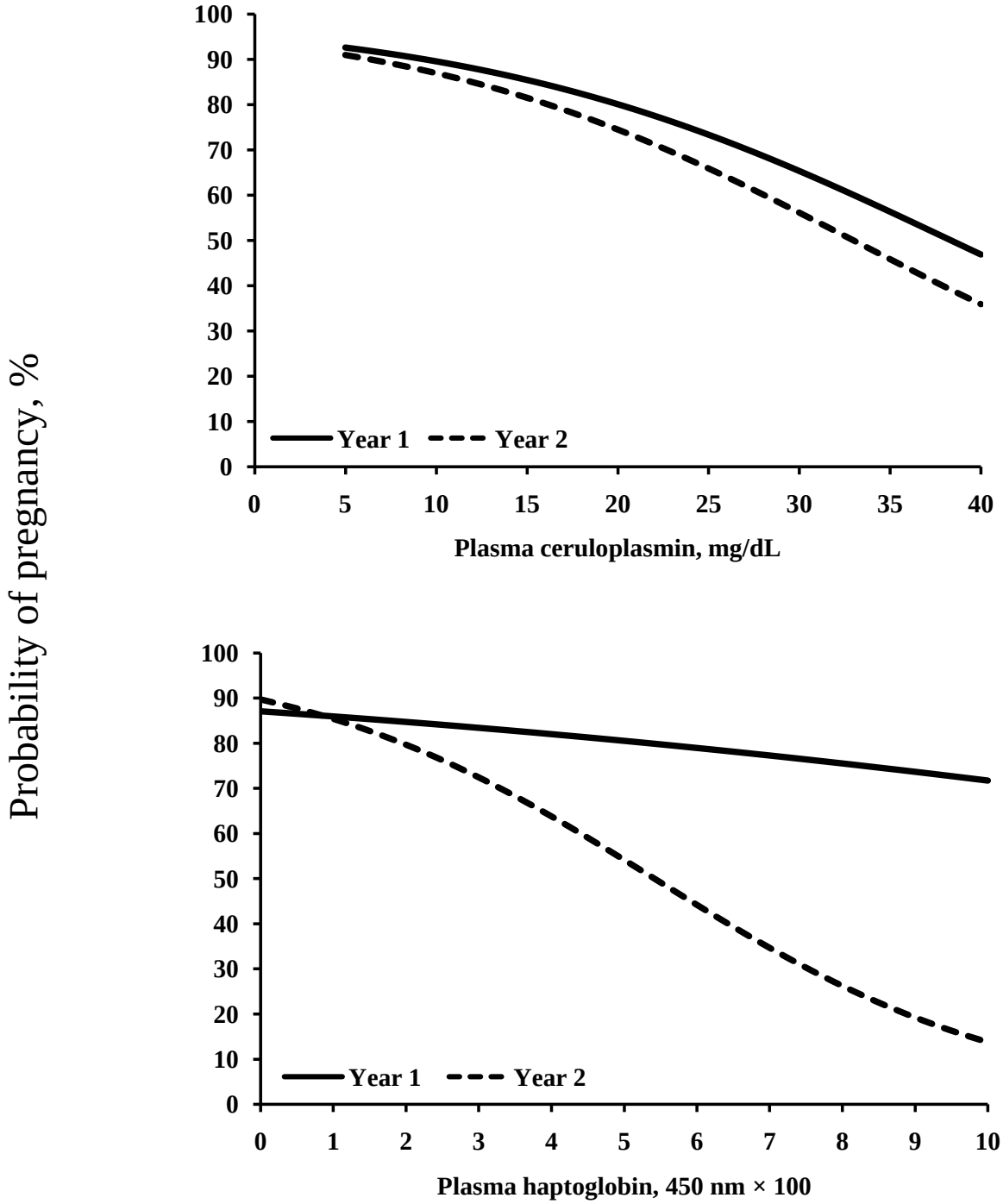

Figure 3. Effects of plasma ceruloplasmin and haptoglobin concentrations, assessed at the beginning of the breeding season, on the probability of Brahman-crossbred cows to become pregnant. A linear effect was detected during yr 1 and 2 for plasma ceruloplasmin ($P<0.01$ and $=0.01$, respectively) and haptoglobin ($P=0.04$ and $=0.01$, respectively).