ABSTRACT: The objective was to determine the effects of natural- or synthetic-source vitamin E on reproductive efficiency in Angus-cross beef cows. In Exp. 1, one hundred fifty-two cows were fed hay and corn silage based diet and assigned to 1 of 3 dietary supplements (3 pens/treatment): 1) containing no additional vitamin E (CON), 2) formulated to provide 1,000 IU·d⁻¹ of synthetic-source vitamin E (SYN; all-rac or dl-α-tocopherol acetate), or 3) formulated to provide 1,000 IU·d⁻¹ of natural-source vitamin E (NAT; RRR or d-α-tocopherol acetate). In Exp. 2, seventy-five cows (2 reps/treatment) were assigned to similar treatments as Exp. 1; however, a vitamin-mineral supplement was offered for ad libitum intake and vitamin intake was calculated from predicted mineral intakes. Cows grazed pastures rather than being fed hay and corn silage as in Exp. 1. In Exp. 1 and 2, supplementation began 6 wk prepartum and continued until initiation of the breeding season. Blood samples were collected at calving (Exp. 1) or breeding (Exp. 2) to determine α-tocopherol concentration and weekly beginning 4 wk postpartum (Exp. 1) or 7 and 14 d before estrus synchronization (Exp. 2) to determine return to estrus via progesterone concentration. Cows were synchronized and bred by AI based on heat detection; nonresponding cows were time bred (AI) 66 h after PGF₂₀ injection, and cows returning to estrus after AI were bred by natural service. In Exp. 1, cows supplemented with NAT and SYN had greater \((P < 0.001)\) serum concentrations of α-tocopherol at calving compared with CON cows. Dietary supplement did not affect \((P \geq 0.55)\) the percentage of cows cycling before synchronization or the number of days to return to estrus by cows that resumed estrus before synchronization. Cows supplemented with SYN tended to have greater first service conception rates compared with CON and NAT \((P = 0.09)\); however, first plus second services combined and overall conception rates were not affected \((P \geq 0.23)\). In Exp. 2, NAT cows had greater \((P = 0.002)\) concentrations of α-tocopherol at breeding, whereas there was no difference \((P > 0.05)\) between SYN and CON. Supplementation of SYN or NAT did not affect \((P \geq 0.17)\) days to resumption of estrus before breeding, first service, first plus second services combined, or overall conception rates. These data suggest that supplementation of SYN or NAT source vitamin E increased α-tocopherol concentration in cows; however, effects on reproductive efficiency are minimal.

Key words: beef cow, reproduction, vitamin E

INTRODUCTION

To optimize kilograms of calf weaned per cow exposed and maximize economic return, cows should be bred early in the breeding season so as to calve within a condensed time period and produce a heavier, more uniform group of calves at weaning. Therefore, improving reproductive efficiency is of paramount importance to the economic success of the cow-calf producer.

Vitamin E supplementation has improved conception rates in beef heifers (Laflamme and Hidiroglou, 1991) and reduced postpartum interval (PPI) and days to conception in dairy cattle (Campbell and Miller, 1998; Baldi et al., 2000). Furthermore, Quigley and Drewry (1998) suggested that supplementation of 1,000 IU·d⁻¹ of vitamin E was needed to reduce metabolic complications associated with the postpartum period.

Natural-source vitamin E (RRR or D-α-tocopherol) is a more biopotent tocochromanol at 1.36 IU·mg⁻¹, whereas
synthetic-source vitamin E (all-rac or dl-α-tocopherol) exhibits a biopotency of 1 IU·mg⁻¹ (Harris and Ludwig, 1949). Concentrations of α-tocopherol in plasma, colostrum, milk, and blood neutrophils from cows supplemented similar IU of vitamin E were greatest for the RRR treatment, intermediate for all-rac, and least for dairy cows fed no supplemental vitamin E (Weiss et al., 2009).

Although it is well established that Se can in part fulfill many of the functions of vitamin E and may also have a synergistic affect when fed in combination (McDowell, 1989), it is difficult to isolate the effects of Se or vitamin E alone on the animal. The current study was designed to eliminate supplemental Se from the diets of these cows in an attempt to isolate the effects of supplemental vitamin E on beef cattle reproduction. Therefore, we hypothesized that supplementation of 1,000 IU of natural-source vitamin E·d⁻¹ will improve reproductive efficiency in beef cows. Specifically, our objectives were to evaluate the effects of natural- and synthetic-source vitamin E on PPI and overall conception rates.

**MATERIALS AND METHODS**

All protocols for this study were approved by the Purdue Animal Care and Use Committee.

**Exp. 1**

**General.** In a 2-yr study, 152 (2-yr-old n = 78; 3-yr-old n = 74) spring-calving Angus-cross beef cows (n = 77 in yr 1, 75 in yr 2; initial BW = 584 ± 11 SEM kg; initial BCS = 5.3 ± 0.13; 1 = emaciated, 9 = obese; Wagner et al., 1988) were blocked by age (2- and 3-yr-old) and randomly assigned to 1 of 9 pens (3 pens/treatment). Cows were allotted so that each block across treatments was similar in BW and BCS. Beginning an average of 6 wk prepartum, cows were fed 1.6 kg·cow⁻¹·d⁻¹ corn silage [7.8% CP, 69.5% TDN; 10.1 IU·kg⁻¹ α-tocopherol; determined by the Diagnostic Center for Population and Animal Health (DCPAH), Lansing, MI; DM basis] top-dressed (0.91 kg·cow⁻¹·d⁻¹) with 1 of 3 corn (8.3 IU·kg⁻¹ α-tocopherol; DCPAH)-based supplements containing no additional vitamin E (CON), 1,000 IU of synthetic-source vitamin E cow⁻¹·d⁻¹ (SYN; Rovimix E-50 Adsorbate, ADM Alliance Nutrition Inc., Quincy, IL), or 1,000 IU of natural-source vitamin E-cow⁻¹·d⁻¹ (NAT; Vitamin E 405 Natural Source, d-α-tocopheryl acetate, ADM Alliance Nutrition Inc.). Cows were maintained in a dry lot and allowed ad libitum access to grass hay (11.7% CP, 61% TDN; 19.3 IU·kg⁻¹ α-tocopherol; DCPAH), water, and minerals (Table 1) devoid of vitamin E and Se. Supplementation was provided until the beginning of the breeding season. Initial and final cow BW was an average of 2 consecutive BW taken before supplementation. Initial and final BCS was determined from an average of scores taken by 2 trained technicians. At an average of 81 ± 15 (range = 47 to 103) d postpartum, cows were synchronized using the CO-Synch + CIDR program. A controlled intravaginal drug releasing device (CIDR, Pfizer Animal Health, New York, NY) and GnRH (100 μg; Cystorelin, Merial, Iselin, NJ) were administered intramuscularly (i.m.) to cows on d −9. On d −2, the CIDR was removed, PGF₂α (25 mg, i.m.; Lutalyse, Pfizer Animal Health) was administered and cows were monitored for signs of estrous behavior twice daily with those detected in estrus bred by AI 12 h after estrus detection. On d 0, cows not exhibiting estrus by 66 h post-CIDR removal were bred (AI) and given GnRH (100 μg, i.m.). Cows were placed with bulls on d 14 after AI, and pregnancy and fetal age were determined by ultrasonography 104 d after AI. First, first plus second combined, and overall conception rates were determined by ultrasonound data and verified by calving date in relation to AI date.

**Sample Collection.** Blood samples were collected via the coccygeal vein into 5-mL Vacutainer tubes (Becton, Dickinson and Co., Franklin Lakes, NJ) 24 h after parturition for analysis of α-tocopherol concentration and weekly beginning 4 wk postpartum until breeding for analysis of progesterone concentration to determine days to resumption of estrus. Blood samples were immediately refrigerated for 8 h, centrifuged at 939 × g at 4°C for 20 min, serum was decanted, and stored at −20°C.

**Exp. 2**

Seventy-five fall-calving Angus-cross beef cows (ages 2 to 13; initial BW = 576 ± 16.9 kg; initial BCS = 5.5 ± 0.12; 1 = emaciated, 9 = obese; Wagner et al., 1988) were blocked by age (2- to 3-yr-old and ≥4-yr-old) and randomly assigned to 1 of 3 supplemental dietary treatments in 1 of 6 pastures (2 pastures/treatment). Beginning an average of 6 wk prepartum, cows were fed free choice 1) mineral supplementation providing no vitamin E or Se (CON), 2) CON mineral supplement providing 10,000 IU/kg of synthetic-source vitamin E (SYN; Rovimix E-50 Adsorbate, ADM Alliance Nutrition Inc.), or 3) CON mineral supplement providing 10,000 IU·kg⁻¹ of natural-source vitamin E (NAT; vitamin E 405 Natural Source, d-α-tocopheryl acetate, ADM Alliance Nutrition Inc.). Predicted vitamin E intake was based on an estimated intake of 0.10 kg·cow⁻¹·d⁻¹ to provide 1,000 IU of supplemental vitamin E. Because cows were in pastures and had free-choice access to minerals (containing no vitamin E, NAT, or SYN), estimated vitamin E intake was calculated based on estimated mineral intake by measuring mineral disappearance within each replication twice weekly. All cows were maintained on native grass pasture (16% CP; 67% TDN; 42.5 IU·kg⁻¹ of α-tocopherol; DCPAH) and allowed ad libitum access to water. Supplementation was provided until the beginning of the breeding season (removal of CIDR). Initial cow BW was an average of 2 consecutive BW taken before supplementation and
final cow BW was taken on an average of 2 consecutive BW taken at the end of supplementation. Initial and final BCS was determined from an average of scores taken by 2 trained technicians. At an average of 63 ± 16 (12 to 92) d postpartum, cows were synchronized using the CO-Synch + CIDR program using the same procedures described in Exp. 1. Cows were comingled into 1 pasture for detection of estrus and AI. Cows were placed with bulls on d 14 after AI, and pregnancy and fetal age were determined by ultrasonography 90 d after AI. First, first plus second combined, and overall conception rates were determined by ultrasound data and verified by calving date in relation to AI date.

**Sample Collection.** Blood samples were collected via the coccygeal vein into 5-mL Vacutainer tubes (Becton, Dickinson and Co.) 7 and 14 d before estrus synchronization for analysis of α-tocopherol concentration as well as progesterone concentration to determine resumption of estrus. Blood samples were immediately refrigerated for 8 h, centrifuged at 939 × g at 4°C for 20 min, serum was decanted, and stored at −20°C.

**Sample Analyses**

Serum samples were analyzed for α-tocopherol by HPLC. In a 13 × 100-mm glass tube, 250 μL of serum, 250 μL of ethanol containing butylated hydroxy-toluene (0.1 mg/mL), and 20 μL of δ-tocopherol (100 μM) as the internal standard were mixed and vortexed. Hexane (1 mL) was added and samples were centrifuged (3 min, 1,200 × g at 4°C). The hexane layer was removed, the extraction was repeated, and the hexane layers were combined and dried under nitrogen flow at 37°C. The residue was dissolved in 400 μL of ethanol, filtered, transferred to a 300-μL auto sampler vial, and injected for analysis of vitamin E. Tocopherols were separated by isocratic HPLC at 0.8 mL·min⁻¹ using a reverse-phase MD-150 column (150 cm × 3.2 mm, 3-μm particle size; ESA Inc., Chelmsford, MA). The column was equilibrated in ammonium acetate (0.2 M) in a mixture of methanol:ammonium acetate (90:10 vol/vol, pH 4.36). The tocopherol isoforms were eluted over a 15-min period. Monitoring was performed with an electrochemical ESA CoulArray detector (ESA Inc., Chelmsford, MA) with potentials set at 200, 400, 600, and 800 mV. Identification and quantification of vitamin E were accomplished by comparison of retention time and peak areas with the external standard.

Progesterone concentrations were measured using RIA (Coat-A-Count Progesterone kit, Siemens Corp., New York, NY). Briefly, 100 μL of serum and 1 mL of iodinated (²⁵Τ) progesterone were added to progesterone antibody-coated tubes. Tubes were incubated at room temperature for 3 h, decanted, and counted for 1 min in a gamma counter (Cobra II Auto-gamma Counting Systems, Packard Instrument Co., Meriden, CT). Circulating progesterone concentrations were determined from the logit-log representation of the standard curve. Cows exhibiting circulating progesterone concentrations greater than 1 ng·mL⁻¹ for 2 subsequent weekly samples or greater than 2 ng·mL⁻¹ for 1 sample were considered cycling. The intra- and interassay CV were 5 and 2%, respectively.

**Statistical Analyses**

Cow performance and serum data (Exp. 1 and 2) and number of days to estrus (Exp. 1) were subjected to
ANOVA (GLM procedure, SAS Inst. Inc., Cary, NC). Pen was the experimental unit, and measures were averaged within pen (Exp. 1) or pasture (Exp. 2). The model included the effect of dietary supplement, year, age of cow (Exp. 1 was 2- and 3-yr-olds; Exp. 2 was 2- and 3-yr-old, or >3-yr-old), and all possible interactions. Means were separated using LSD when \( P < 0.05 \). Tendencies were reported at \( P < 0.10 \).

To reduce variation associated with pens, detection of estrus, breeding technicians, and clean-up bulls, cows were comingled into 1 pasture once the CIDR was removed for detection of estrus and AI. Therefore, individual animal was used as the experimental unit for breeding data. Percentage of cows cycling before the breeding season and conception and pregnancy rates were analyzed as categorical data using the GLIMMIX procedure of SAS. The model included the effects of dietary supplement, year, age, postpartum estrus, and all possible interactions and \( \alpha = 0.05 \).

### RESULTS

#### Exp. 1

A year \( \times \) age interaction (\( P = 0.01 \)) was detected for PPI. Two-yr-old heifers in yr 1 had a longer PPI compared with 3-yr-old cows, whereas PPI from 2-yr-old heifers in yr 2 did not differ from 3-yr-old cows. A year \( \times \) age interaction (\( P = 0.02 \)) was also detected for first service conception rates. In yr 1, no difference (\( P > 0.05 \)) was detected in first service conception rates between 2- and 3-yr-old cows; however, 3-yr-old cows in yr 2 had greater first service conception rates compared with 2-yr-old cows.

The main effects of natural- or synthetic-source vitamin E supplementation on cow performance and serum concentrations of \( \alpha \)-tocopherol are presented in Table 1. By design, there were no differences in initial BW (\( P = 0.67 \)) or BCS (\( P = 0.97 \)). Neither final BW (\( P = 0.11 \)) or final BCS (\( P = 0.75 \)) differed between treatments. Circulating \( \alpha \)-tocopherol concentrations were greater (\( P < 0.001 \)) in cows supplemented SYN and NAT compared with CON.

The percentage of cows that resumed estrus (\( P = 0.55 \)) before the breeding season and the number of days to first estrus (\( P = 0.84 \)) of cows that did resume estrus was not affected by dietary treatment (Table 2). First service conception rate tended to be greater (\( P = 0.09 \)) in SYN compared with NAT and CON cows. First plus second combined conception rates were not affected (\( P = 0.23 \)) by dietary supplementation, nor was overall conception rate (\( P = 0.56 \)).

Initial and final BW and BCS (\( P < 0.001 \)) were greater in yr 1 than yr 2 cows and were greater in 3-yr-old compared with 2-yr-old cows. More cows in yr 1 conceived on first service (\( P = 0.001 \)) compared with yr 2. Fewer cows in yr 1 tended to conceive on the first plus second service combined (\( P = 0.06 \)) than yr 2.

#### Exp. 2

No interactions (\( P > 0.05 \)) were detected in Exp. 2; therefore, only main effects are presented. Average intake of the free-choice vitamin E supplement was 0.05, 0.05, and 0.07 kg·d\(^{-1}\) for CON, SYN, and NAT cows, respectively, which was less than the predicted intake of 0.10 kg·d\(^{-1}\). This resulted in a calculated intake of 500, 500, and 700 IU of supplemental vitamin E·d\(^{-1}\) for the CON, SYN, and NAT cows, respectively.
The effects of natural- or synthetic-source vitamin E supplementation on cow performance and serum concentrations of α-tocopherol are presented in Table 3. There were no differences in initial BW (P = 0.21), final BW (P = 0.94), or final BCS (P = 0.75); however, initial BCS was greater (P = 0.009) in CON and SYN compared with NAT. Circulating α-tocopherol concentrations were greater (P < 0.001) in cows supplemented with NAT compared with SYN or CON.

Cows less than 3 yr of age had lighter initial BW (P < 0.001), final BW (P < 0.001), and final BCS (P = 0.03) compared with cows greater than 3 yr of age.

### DISCUSSION

Hidiroglou et al. (1992) and Wichtel et al. (1996) suggested that bovine serum concentrations of α-tocopherol less than 2 μg·mL⁻¹ are considered deficient and greater than 4 μg·mL⁻¹ are considered adequate. Lack of differences detected in serum vitamin E concentrations between synthetic- and natural-source vitamin E in Exp. 1 are contrary to other studies (Hidiroglou et al., 1992, 1995; Weiss et al., 2009). Blood samples in Exp. 1 were collected at parturition when circulating concentrations of vitamin E are least (Weiss et al., 1990, 2009; Hidiroglou et al., 1995). Although both treatments of vitamin E-supplemented cows in Exp. 1 had greater circulating serum α-tocopherol concentration than control cattle, there was a lack of response between vitamin E source and overall concentrations of α-tocopherol were reduced in all treatments groups. These results are consistent with Loudenslager et al. (1986), who re-

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<th>Natural vitamin E¹</th>
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¹Mean within a row with unlike superscripts differ.
²Supplements contained 11.4% Ca, 5.13% P, 1.1% Mg, 0.77% K, 0.32% S, 9.5% sodium, 9.25 mg/kg of Fe, 1,657 mg/kg of Cu, 3,090 mg/kg of Mn, 16.9 Co, 62% I, 3,200 mg/kg of Zn, and 116 kIU·kg⁻¹ of vitamin A.
³Cows were allowed ad libitum access to native grass/fescue pastures containing 42.5 IU·kg⁻¹ of α-tocopherol and Se >0.5 mg·kg⁻¹ [Diagnostic Center for Population and Animal Health (DCPAH), Lansing, MI].

### DISCUSSION

Hidiroglou et al. (1992) and Wichtel et al. (1996) suggested that bovine serum concentrations of α-tocopherol less than 2 μg·mL⁻¹ are considered deficient and greater than 4 μg·mL⁻¹ are considered adequate. Lack of differences detected in serum vitamin E concentrations between synthetic- and natural-source vitamin E in Exp. 1 are contrary to other studies (Hidiroglou et al., 1992, 1995; Weiss et al., 2009). Blood samples in Exp. 1 were collected at parturition when circulating concentrations of vitamin E are least (Weiss et al., 1990, 2009; Hidiroglou et al., 1995). Although both treatments of vitamin E-supplemented cows in Exp. 1 had greater circulating serum α-tocopherol concentration than control cattle, there was a lack of response between vitamin E source and overall concentrations of α-tocopherol were reduced in all treatments groups. These results are consistent with Loudenslager et al. (1986), who re-

Table 3. Effects of natural- or synthetic-source vitamin E supplementation on cow performance and serum α-tocopherol concentration for Exp. 2

Table 4. Effects of natural- or synthetic-source vitamin E supplementation on resumption of postpartum estrous cycles and conception rate for cows in Exp. 2
ported rapid decline of plasma tocopherol at parturition in sows, which is likely attributed to increased utilization of vitamin E in colostrum. Additionally, these cows were fed stored feeds, which likely had reduced content of vitamin E. In contrast, increased concentration of α-tocopherol in NAT compared with SYN cows in Exp. 2 agrees with previously reported data, which present differing concentrations of α-tocopherol between NAT and SYN supplements. There was almost a 40% difference between vitamin E consumption between the NAT and SYN treatments (700 and 500 IU, respectively). However, it is not clear why cattle from Exp. 2 had a response between sources of vitamin E supplements and cattle from Exp. 1 did not. Control animals in Exp. 1 were borderline deficient in circulating α-tocopherol concentrations. Although an increase in circulating α-tocopherol concentrations due to both sources of vitamin E supplementation was observed, these animals were still not in the adequate range. Perhaps the greater biopotency of natural-source vitamin E would have been realized if supplementation rates of vitamin E were greater. Control animals in Exp. 2, although not considered adequate in circulating concentrations of α-tocopherol, were not considered deficient and had 31% greater concentrations of circulating α-tocopherol compared with their control counterparts in Exp. 1, likely explained by the greater concentrations of α-tocopherol contained in the pastures (42.5 IU/kg) grazed by cows in Exp. 2 compared with feeds (19.3, 10.1, and 8.3 IU/kg, for hay, corn silage, and corn, respectively) supplied to cows in Exp 1.

Cows in Exp. 2 were allowed continuous access to grass pasture, while being provided vitamin E supplementation. Grasses generally contain greater amounts of vitamin E than stored forages and the pasture in this study contained 42.5 IU·kg−1, which may have negated any benefit of additional vitamin E supplementation (McDowell, 1989; Wichtel et al., 1996) and explain why all cows, including controls, in yr 2 had greater serum vitamin E concentrations compared with cows in yr 1 that had been fed harvested feeds in a dry lot. Supplement intake in Exp. 2 when cows were maintained on pasture was less than expected, which may lead to decreased effects of supplementation. Perhaps, if the cows had received the full 1,000 IU·d−1 of SYN or NAT supplementation, this may have further increased the concentration of α-tocopherol relative to CON cows, which received no additional vitamin E supplementation. Alternatively, NAT cows did have greater circulating α-tocopherol concentrations; perhaps more animals would provide the statistical power required to detect a significant difference.

Resumption of estrus before the breeding season and the number of days to estrus among cycling cows were not improved by supplementation of natural- or synthetic-source vitamin E in Exp. 1 or 2, which is in contrast to Harrison et al. (1984) and Baldi et al. (2000) who reported an improvement in number of days to resumption of estrus and days to conception due to vitamin E supplementation. In agreement with the current study, Wichtel et al. (1996) reported no difference in return to postpartum cyclicity with supplementation of vitamin E. Vitamin E may improve uterine and ovarian function through its antioxidative and immune-enhancing properties (Brzezinska-Slebodzinska et al., 1994; Allison and Laven, 2000), but the lack of improvement in resumption of postpartum estrus in the current study does not support this. Incidence of reproductive challenges such as retained placenta, metritis, and pyometra were not measured in the present study; however, Harrison et al. (1984), reported that vitamin E alone had no effect on incidence of retained placenta, metritis, or cystic ovaries. In contrast, other researchers (Campbell and Miller, 1998; Baldi et al., 2000) have reported that vitamin E-supplemented cows still had decreased days to first estrus and breeding, suggesting that improvement in reproductive performance due to vitamin E supplementation might be occurring via other mechanisms. In the study of Harrison et al. (1984), a significant reduction in the incidences of retained placenta occurred when vitamin E was supplemented in conjunction with Se. It is well established that Se can in part fulfill many of the functions of vitamin E and may also have a synergistic effect when fed in combination (McDowell, 1989).

Therefore, it is often difficult to isolate the effects of Se or vitamin E on animal measures and may in part explain differences in response between studies. However, the current study was designed to eliminate supplemental Se in the diet of these cows in an attempt to isolate the effects of vitamin E on beef cattle reproduction. Perhaps if Se were supplemented with vitamin E, a greater response would have been realized.

Cow age affected PPI before the breeding season in Exp. 1 with a greater percentage of 3-yr-old (second parity) cows resuming estrus before the breeding season compared with 2-yr-old (first parity) heifers. Postpartum interval is greater in 2-yr-old (first parity) heifers due to greater nutrient demands, a greater incidence of dystocia, and longer uterine involution compared with pluriparous beef cows (Bellows et al., 1982; Strauch et al., 2001; Renquist et al., 2006).

Although no explanation is readily apparent for improved first service conception between sources of vitamin E, the overall tendency for increased first service conception rate in Exp. 1 for cows supplemented with vitamin E could be due to the role of vitamin E in preventing early embryonic death and fetal resorption as demonstrated in rats by Evans and Bishop (1922). Rats reared on vitamin E-deficient diets showed normal ovarian behavior, but had increased fetal resorption by the second day of gestation. Early embryonic death has been associated with premature luteolysis of the CL. Prostaglandin F2α causes luteolysis of the CL and is derived from arachidonic acid through the cyclooxygenase pathway (Murdoch et al., 1993; Mattos et al., 2000). A vitamin E deficiency may result in increased PGF2α concentrations through enhanced phospholipase A or cyclooxygenase activity within the cyclooxygenase
pathway (Panganamala and Cornwell, 1982), which may result in premature PGF$_2\alpha$ release, luteolysis, and early embryonic death. Therefore, perhaps the decreased first service conception rates in CON cows from Exp. 1 are attributed to their almost deficient circulating vitamin E status.

Laflamme and Hidiroglou (1991) reported improved overall conception rates when natural-source vitamin E was supplemented as compared with cows receiving no additional vitamin E. However, no differences were noted in overall conception rates in Exp. 1 or 2 due to vitamin E supplementation; nevertheless, NAT cows displayed numerically greater overall conception rates than SYN and CON cows by nearly 7 and 10 percentage points in Exp. 1, and SYN cows had 100% overall conception rate in Exp. 2. However, CON cows had a numerically greater conception rate than NAT cows in Exp. 2.

In conclusion, supplementation of natural- and synthetic-source vitamin E increased circulating $\alpha$-tocopherol concentration in dry-lot and pasture-fed cows; however, baseline concentrations of vitamin E may have been sufficient in cows that were maintained on grass pasture. Prebreeding cyclicity as well as overall conception rates were not affected in the current studies. Further research is needed to elucidate differences between supplementation source, and the lack of differences in prebreeding cyclicity due to both vitamin E supplementation sources, as well as the effects of supplementation at levels greater than 1,000 IU·d$^{-1}$.

**LITERATURE CITED**


