Do elevated nitrate concentrations in wheat forage affect performance of fall stocker cattle?

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ABSRACT

Winter wheat (Triticum aestivum L.) is the predominate cool-season forage grown in the southern Great Plains and is considered an excellent forage capable of producing gains greater than 1.4 kg/day in stocker cattle (Bos taurus L.). Occasionally properly processed stocker cattle gain little or no weight after initial turnout on fall wheat pasture. Shoots of small grain cereals can accumulate elevated concentrations of nitrate that reportedly pose performance and health risks to ruminants. From 2002 to 2006 we measured nitrate concentration of clipped wheat samples within 8 d of the onset of fall grazing and recorded weight gains of yearling stocker steers after 23 to 69 d of grazing. Yearly broadcast applications of 45 kg N/ha were made 2 to 4 weeks before forage sampling, except in 2004 when 90 kg N/ha was applied. Across years forage nitrate-N differed as much as 11-fold (range 590 mg/kg DW in 2002 to 6600 mg/kg DW in 2004). Cattle weight gains ranged from -0.03 to 1.34 kg/day. The -0.03 kg/day value occurred in 2004. A high stocking rate (1,900 kg/ha) was chosen in 2004 because of abundant fall forage (3960 kg/ha), but excessive rain (13 cm; about 3-fold > normal) leading up to and after initiation of grazing resulted in severe pasture trampling and only 23 d of grazing. With 2004 results excluded, the correlation between cattle weight gains and forage nitrate concentrations (590, 760, 1300, and 1600 mg/kg DW) was not significant (P = 0.89) even though the two highest nitrate levels were above the lowest value considered safe for all cattle.

1. INTRODUCTION

- Each year nearly 4.9 million ha of winter wheat in Oklahoma and Texas (NASS, 2006) is used one of four ways:
  - Dual-purpose (forage + grain)
  - Graze-only
  - Grain-only
  - Hay / silage
- Positive attributes of wheat pasture and forage:
  - Highly digestible for grazing livestock
  - High N content with abundant levels of soluble and non-protein N
- Negative attributes of wheat pasture and forage:
  - High water content and low Ca and Mg
  - Grazed pastures can cause bloat in ruminants
  - High non structural carbohydrates, particularly fructans, may be linked to laminitis in horses (Bailey et al., 2002; Longland and Byrd, 2006)
  - Nitrate accumulation can pose performance and health risks to ruminants (Fig. 1 and Table 1; Strickland et al., 1995; Undersander et al., 1999).
- Some factors known to affect nitrate accumulation in forages:
  - High levels of soil mineral nitrogen
  - Adverse climatic conditions
  - Other factors include low light intensity, nutritional imbalances, herbicide injury, diseases
  - Nitrate concentration in fall forage differs among wheat cultivars (MacKown and Carver, 2005)
  - Nitrate concentration of wheat stems are greater than leaf blades (Knowles et al., 1989)

Fig. 1. Fate of NO_3^- ingested from feed and water by ruminants.

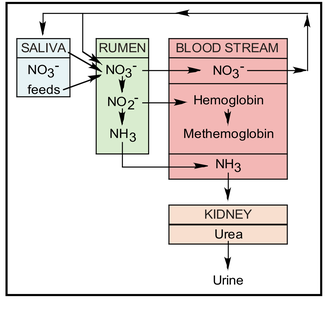


Table 1. Forage NO_3^--N concentrations and associated risk levels for cattle.

Forage NO_3^--N µg/g	Risks to cattle
< 1000	Generally safe for all cattle
1000 - 2000	Generally safe; pregnant cattle ≤ 50% feed
2000 - 4000	Some risk for all cattle; limit to < 50% intake
> 4000	Potentially toxic for all cattle; do not feed

2. OBJECTIVE

- Evaluate if nitrate accumulated in fall wheat pasture affects the performance of stocker calves after fall turnout.
- Evaluate nitrate distribution patterns in wheat forage at the onset of fall grazing and at first hollow stem when cattle would be pulled in a graze + grain production system.

3. MATERIALS AND METHODS

Grazing experiment

- A 2 ha wheat pasture on a Bethany silt loan (fine, mixed, superactive, thermic Pachic Paleustolls) was planted yearly in a conventional tilled field in mid September. Wheat had been grown for nearly 30 yr at the site and was in clean fallow for about 15 mo before the start of the experiment.
- Broadcast applications of N fertilizer were made in mid October about two weeks before collecting forage samples within 8 d of the onset of grazing.
- Forage samples (n = 48) were collected from two transects by clipping an 0.5 m length of row to a stubble height of 4 cm.
- Samples were oven dried at 60°C to constant weight, ground, extracted with deionized water, and the extracted nitrate assayed by an enzymatic microplate method (MacKown and Weik, 2004).
- Predominately Angus calves (237±15 kg steers weaned and processed for 1 mo) began grazing just after mid November. Stocking rate was adjusted each year to match amount of available forage to provide enough forage to sustain grazing for 60 d or less.

Nitrate distribution experiment

- Endurance and 2174 wheat cultivars were planted in plots receiving preplant incorporated applications of urea N fertilizer (0-336 kg/ha).
- Forage samples were collected by clipping four 0.5 m rows to a stubble height of 4 cm from each plot. Nitrate was analyzed in pseudo-stem and leaf blade tissues as in described above.

4. RESULTS

Table 2. Forage dry matter yield and nitrate concentration of wheat pasture just before the onset of fall grazing with stocker calves and the number of days and average daily gains (ADG) of the calves. Row color corresponds to expected nitrate risk levels presented in **Table 1**.

	Cultivar, yield, and nitrate concentration							Cattle		
Year	N	cv	Yield	Range	Median	Mean		n	Days	ADG
	kg/ha		kg/ha	—— µg NO_3^-–N/g DW ——					d	kg/d
2001	0	2174	2040	520-7600	5350	5250		–	–	–
2002	40	2174	1190	110-1400	491	585		3	69	0.68
2003	40	2174	2000	270-2400	1330	1250		9	50	1.27
2004	90	OK101	3960	4500-8700	6630	6580		15	23	-0.03
2005	40	OK101	3190	150-2090	718	761		4	24	1.34
2006	40	2174	3650	105-2920	1660	1600		11	68	0.72

Fig. 2. Relationship between average daily gain (ADG) of steers and forage nitrate concentration just before the onset of fall grazing. Colored panels within the graph correspond to the expected nitrate risk levels presented in **Table 1**.

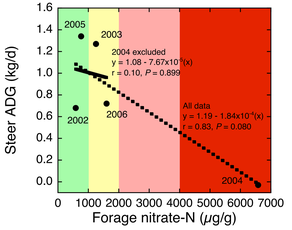
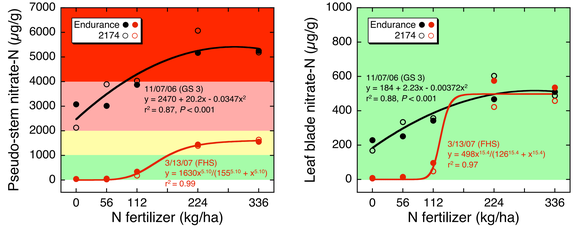


Fig. 3. Wheat forage pseudo-stem and leaf blade nitrate concentration responses to soil incorporated fertilizer N applied preplant. Endurance and 2174 cv. were sampled at the onset of grazing (Feekes growth stage 3 (GS 3); Large, 1954) and at first hollow stem (pre jointing, GS 6). Colored panels within the graph correspond to expected nitrate risk levels presented in **Table 1**.



5. SUMMARY

Are the guidelines for forage nitrate risks appropriate for stockers grazing fall wheat pasture?

ANSWER: Depending on grazing pressure, the existing risk levels and their associated nitrate concentration levels may be appropriate.

Intensive grazing pressure leading to consumption of wheat leaf blades **and** pseudo-stems would expose livestock to greater intake of nitrate.

Light grazing pressure that removes mostly leaf blades of wheat would reduce intake of nitrate.

6.ACKNOWLEDGEMENT

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