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Nitrate QuikTest for Rapid Detection of High Nitrate Levels in Forages

Abstract
The Nitrate "QuikTest" Program was implemented in 2000 to assist Montana livestock producers in dealing with toxic levels of nitrate in drought-stressed forages. A certification program similar to that for pesticide applicator licensing was developed for safe use and interpretation of the test. All training materials and examinations are now posted on an interactive Extension Web site. Since 2000, 110 users in 50 counties (89% of Montana counties) have been certified to conduct the Nitrate QuikTest, and 6,615 samples were evaluated. This has been a high-impact, timely program to educate and serve our livestock producers.

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Introduction

Annual cereal forage crops (wheat, barley, oat, triticale, and others) are grown for hay on several hundred thousand acres. When cereals are grown under stressful conditions such as drought, these crops can accumulate levels of nitrate that are toxic to livestock (Cash, Funston, King, Wichman, 2002). High forage nitrate levels can cause many chronic symptoms, and in extreme cases result in abortion and death. The Montana State University Extension Service (MSU-ES) "Nitrate QuikTest" Program was initiated in 2000 to respond to the widespread problem of nitrate toxicity in hay crops produced under drought conditions. The Nitrate QuikTest was implemented to:

1. Provide formal and standardized training for our agricultural agents,
2. Maintain this useful service for livestock producers, and
3. Increase awareness about potential nitrate problems in this expanding roughage source.

Educational Approach

Training and Certification

A qualitative nitrate "spot" test (Helwig & Setchell, 1960) has been used by MSU-ES county agents since the 1960's, but was discontinued in 1999 due to liability concerns. The Nitrate QuikTest Program was initiated in 2000, and it requires formal training and annual certification similar to that for pesticide applicator licensing. The training materials consist of ES bulletins (Cash et al., 2002; Undersander et al., 2000) and research papers about nitrate toxicity, MSDS information, testing laboratories, and the Nitrate QuikTest protocols. The written examinations consist of multiple choice questions, which can be answered using all the reference materials.

In 2002, all training materials and certification/re-certification examinations were posted online <http://www.animalrangeextension.montana.edu/ ExtnAgents/Articles/Forage/Nitrate/index.htm> with continued opportunities for traditional training available.

Nitrate Testing

Due to the frequent incidence of nitrate accumulation, a rapid field test is needed to diagnose high nitrate levels prior to haying dryland cereals. The Nitrate QuikTest solution consists of 0.5 g diphenylamine dissolved in 20 ml distilled water, with the volume brought to 100 ml with 98% sulfuric acid (Anonymous, 1998). The Nitrate QuikTest kits contain the test solution, razor blades, eyedropper, safety goggles, rubber gloves, test protocol, training manuals, and the material data safety sheets (MSDS) for sulfuric acid and diphenylamine. There is a one-time fee of $20 for the test kit and training materials and replacement solution is prepared as needed and provided free of charge.

Outputs and Impact

The Nitrate QuikTest Program was implemented at an opportune time. Due to extreme droughty conditions throughout Montana since 1999, many cereal crops were harvested as emergency forage with a high incidence of elevated nitrate levels. Since 2000, we have certified 110 people in 50 counties (89% of all Montana counties, including two in Wyoming) to use the Nitrate QuikTest (Table 1). Twenty-three administrative assistants, 12 crop consultants, and 18 individual producers have been certified. Certification of crop consultants and producers has been very effective in many of our rural counties where grain producers reside over 25 miles from their county seat.

Certified users of the Nitrate QuikTest have quickly adopted the online training and certification process; in 2003, 98% of certification or re-certification examinations were completed online. The Internet site was originally intended to complement traditional in-service agent training; however, the online version has quickly evolved as the predominant educational tool for both agents and producers. Conventional hands-on training is still available for inexperienced new users, but rapid acceptance of the Intranet site has saved time, travel, and resources.

Table 1.
Certified Nitrate QuikTest Users and Training or Re-Certifying Methods from 2000-2003

Year	Training Method	Agents	Staff	Producers	Consultants	Total
2000	Traditional*	44	13	8	7	72
2001	Traditional	33 (31 R)	7 (3 R)	2	0	42 (34 R)
2002	Traditional	26 (21 R)	4 (1 R)	4	5 (3 R)	39 (25 R)
	Online**	13 (10 R)	2 (1 R)	1	2	18 (11 R)
2003	Traditional	0	0	0	1	1
	Online	29 (26 R)	9 (7 R)	3	1 (1 R)	42 (1 R)
Total	Traditional	103 (52 R)	24 (36 R)	14	13 (3 R)	154 (59 R)

	Online	42 (36 R)	11 (8 R)	4	3(1 R)	60 (45 R)

*Traditional = classroom training, handouts, written examinations for certification.
**Online = training and examination for certification on intranet site.
R = Re-certification examinations.

The Nitrate QuikTest has had an immediate and direct impact in Montana counties where annual cereal forages are harvested. Through 2002, Nitrate QuikTests were conducted on 6,615 forage samples, and 68% of the samples were toxic or questionable, requiring a delay in harvest and a laboratory nitrate test prior to feeding (Table 2).

Table 2.
Nitrate QuikTest Results from 2000-2002 Testing

	Number of Samples	**Test Results (N [% of Total])**		
Year		**Toxic***	**Marginal**	**Safe**
2000	1712	599 [35%]	497 [29%]	616 [36%]
2001	2824	1186 [42%]	763 [27%]	875 [31%]
2002	2079	894 [43%]	561 [27%]	624 [30%]
Totals	6615	2679 [40%]	1821 [28%]	2115 [32%]

*"Toxic" indicates rapid, intense staining associated with high nitrate concentrations; hay from this field must be tested prior to feeding. "Marginal" refers to intermediate or questionable nitrate results that require caution. "Safe" indicates that the hay is most likely safe to feed.

The MSU-ES Nitrate QuikTest is a very successful outreach program, helping producers avoid costly livestock deaths or abortions due to forage nitrate toxicity. The economic impact of the nitrate problem in Montana cereal forages since 2000 has been estimated at between $13 million (replacement value of toxic high-nitrate hay) to $39 million (potential calf abortion losses) annually. The Nitrate QuikTest is a free service to livestock producers, and this program has reached many new Extension clients in the hay, feed, and animal care industries.

Additionally, Extension agents have an opportunity each year to discuss forage quality testing and general livestock nutrition issues with their clients. They also gain experience in field testing and participate in and measure the impacts of a relevant program and do so at little additional cost. We believe that the Nitrate QuikTest Program is a useful model for implementing timely, economical, and high-impact Extension programs.

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