OLDS COLLEGE OF AGRICULTURE & TECHNOLOGY | TECHNOLOGY ACCESS CENTRE FOR LIVESTOCK PRODUCTION

Technology Access Centre for Livestock Production (TACLP)

2022 Study: Validation of Rapid In-Field Testing to Measure Forage Nitrate Concentration

INTRODUCTION

Nitrate levels exceeding a certain threshold are toxic to cattle and can lead to reduced weight gain, depressed appetite, greater vulnerability to infections, and potentially death.

To increase forage nitrate testing by Alberta producers, protocols must be practical, quick, inexpensive and reasonably accurate. There are rapid in-field testing methods available for forage nitrates in North America, but adoption by local producers is low and the tests needed to be validated within an Alberta farming context with local crop varieties and unique environmental conditions.

The TACLP performed a study in 2021 and 2022 to assess and validate the accuracy of rapid nitrate test kits for on-site measurement of nitrate concentrations in forages. The goal is to provide livestock producers information on the accuracy and applicability of in-field methods for rapid nitrate testing to help lower the production/health losses associated with nitrate toxicity.

OBJECTIVES

- Verify the accuracy of two rapid nitrate test kits (Horiba and NECi nitrate tests) in measuring nitrate concentration in forages by comparing them to industry-standard wet chemistry lab analysis.
- Investigate the effect of environmental stressors such as hail damage, hard frost and drought on the accumulation of nitrate in fresh and dry forages.
- Assess how nitrate levels are affected by the management factors including fertilization, irrigation and crop type.

STUDY DETAILS

Sample collection

- Forage sample collection took place throughout 2021 and 2022 at various farms across Alberta including pasture and hay bale lots identified with a possible risk of nitrate accumulation after experiencing a hard frost (<-5 C) or suffering severe drought or hail damage. Additional information was collected on overall plant species composition, fertilization and irrigation.
  - Dry hay samples (n=29) from round bales of 3 types of hay: a) a mix of legumes and grasses (n=16), b) grass only (n=10), and c) cereals only (n=3) (oats, barley, wheat).
  - Standing forage samples (n = 52) were obtained from several types of standing forages: a) alternative (n = 4), b) cereals only (n = 5), c) grasses only (n = 5), d) a multispecies forage mix (crop cocktail; n = 18), e) legumes only (n = 9), and f) a mix of legumes and grasses (n = 7).

Rapid nitrate analysis

- All dry hay samples and standing forage samples in which no sap or wet extract was available were analyzed in duplicates using the Dry Forage NECi Nitrate Test Kit.
- The standing forage samples in which sap or wet extract was available were analyzed in duplicate using the Green Forage NECi Nitrate Test Kit and the Horiba LAQUAtwin NO3-11 test kit.
- All tests were performed following the kit manufacturer's protocol, and tests were converted to NO_3^--N (Nitrate-N) so that all the results were measured in a common unit and comparable.

Learn more at oldscollege.ca/TACLP

Technology Access Centre for Livestock Production (TACLP)

2022 Study: Validation of Rapid In-Field Testing to Measure Forage Nitrate Concentration

STUDY DETAILS *(continued)*

Laboratory analysis (wet chemistry)

- Material from each dry hay and standing forage sample was sent to a commercial lab in Alberta for wet chemical analysis of nitrate concentration.

Statistical analysis

- 70 forage samples remained in the final dataset after sample type, composition, fertilization, stress, irrigation and random effect of sample origin were analyzed.
- Comparison of nitrate-N measurement between the lab web chemical analysis and the two selected quick in-field tests were conducted with paired Wilcoxon signed rank test, Spearman correlation and Bland-Altman plot.
- The TACLP categorized the measured nitrate-N ppm contents into four ordinal groups: (1) <350 ppm, (2) 350-1000 ppm, (3) 1000-2500 ppm, and (4) >2500 ppm. Wilcoxon signed-rank test was then performed to these ordinal differences between the lab wet analysis and in-field quick tests.

RESULTS

- Results indicate that sample type, species composition, environmental stress, and land management have a significant effect on the level of nitrate-N in forages. Specifically, dry hay samples had significantly higher nitrate-N levels compared to standing forage samples, forages consisting of cereals only had significantly higher nitrate concentrations compared to all other forage types, and forage samples from stressed fields had significantly higher nitrate-N levels compared to non-stressed fields.
- The study also found that irrigation had a significant effect on the concentration of nitrate-N concentration with irrigated fields having roughly double the amount of nitrogen-N compared to non-irrigated fields. The results suggest that local producers should be made aware of the potential impacts associated with field conditions and management practices on nitrate-N concentration.
- Additionally, the TACLP found that the Horiba test and the NECi Nitrate test provide sufficiently accurate data on the nitrate concentration of fresh forage samples compared to the wet lab analysis. Both tests also provide much faster results compared to sending samples for analysis in a laboratory. The adoption of either of these tests could increase uptake of nitrate testing by producers in Alberta, thereby reducing losses associated with nitrate toxicity in livestock.
- The NECi Nitrate kit seemed to overestimate the concentration of nitrate in dry forage samples (dry hay samples or dead plant samples); however, further investigation is warranted to verify if the laboratory that analyzed the dry forage samples potentially underestimated their nitrate-N concentration.

CONCLUSIONS

Environmental stress and land management appear to have a significant effect on the level of nitrate in forages, which suggests that Alberta producers should be more aware of the potential impacts associated with field conditions and management practices on nitrate concentration.

Ultimately, this study illustrates that rapid on-farm nitrate tests could assist Alberta producers in adequately managing their forage sources, while also presenting opportunities to further investigate hand-held devices in their ability to quantify nitrate in dry forages.

Learn more at oldscollege.ca/TACLP