Nitrates in grazed forages
How much is too much?

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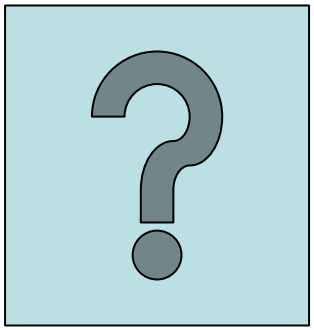

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Any annual (and even perennials) can accumulate nitrates

Some plants are more prone than others

- Lambs quarter
- Pigweed
- Brassicas
- Johnson grass
- Millet
- Sudangrass
- Sorghum
- Alfalfa
- Corn
- Small cereals
- Bermudagrass
- Sweetclover

Any situation that reduces growth, but the plant is still living can result in high nitrates

Current dietary nitrate thresholds of various state extension programs

State Extension Program	Author, Year	Safe to feed level	Toxic to feed level
		NO_3-N ppm	
Pennsylvania	Adams et al., 1992	< 1000	> 1700
Kansas	Roozeboom et al., 2011	< 1380	> 2070
Nebraska	Rasby et al., 2014	< 1500	> 2100
Oklahoma	Strickland et al., 2017	< 1150	> 2300
Colorado	Whitter, 2014	< 1150	> 2300
Iowa	Ensley and Barnhart, 2012	< 1500	> 2300
UC Davis	Maas, 2001	< 1500	> 4000
Florida	Halsey, 1998	< 1518	> 4048
North Dakota	Stoltenow and Lardy, 2015	< 1500	> 4500

*Calculations done using conversion factors in Adams et al. (1992)

Montana Nitrate Thresholds

NO_3-N (ppm)	Comments
<350	Generally safe for all conditions and livestock
350-1130	Generally safe for non-pregnant livestock. Potential early-term abortions or reduced breeding performance. Limit use to bred animals to 50% of the total ration.
1130-2260	Limit feed to 25-50% of ration for non-pregnant livestock. DO NOT FEED TO PREGNANT ANIMALS may cause abortions, weak calves and reduced milk production.
>2260	DO NOT FEED. Acute symptoms and death.

Cash et al. Nitrate Toxicity of Montana Forages

Should we be concerned?

Trial	Forage	N03-N, ppm
1452	Oat, Turnip, Radish	**6146**
1544	Oat, Turnip, Radish	**4655**
1545	Oat, Turnip, Radish	**2158**
1546	Oats (Hill)	912
1546	Oats(Valley)	**4414**
1641	Oats (Hill)	**3921**
1641	Oats (Valley)	**8026**

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Review

Is it time to rethink our one-size-fits-all approach to nitrate toxicity thresholds in forages?

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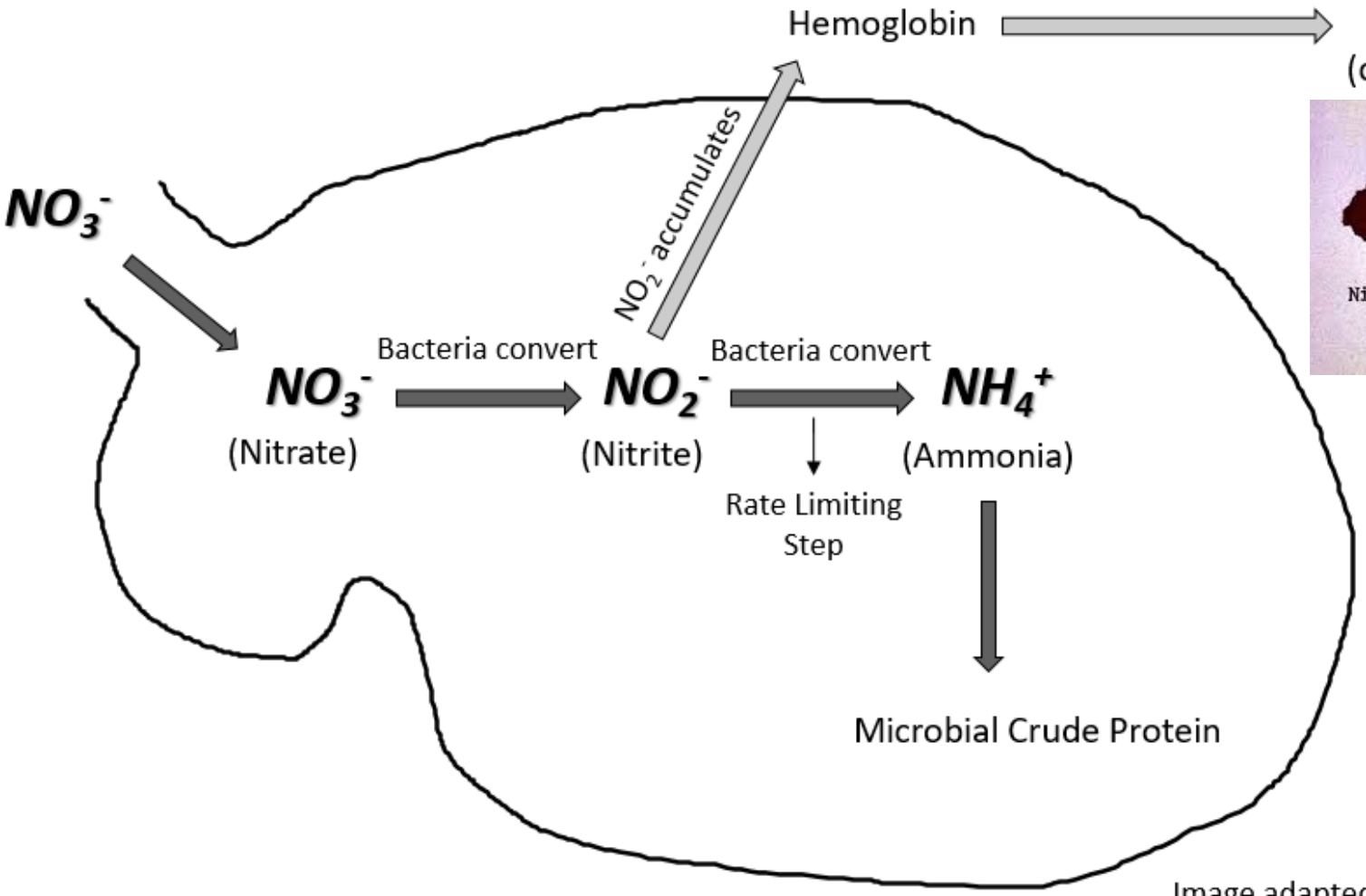


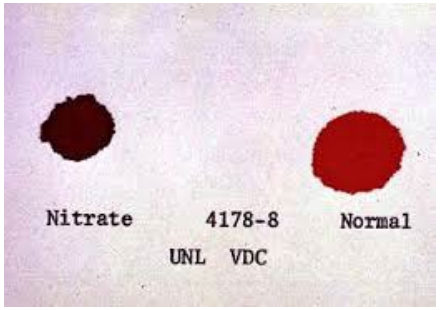


Image adapted from J. MacDonald

Methemoglobin

- Clinical signs 40% to 60% methemoglobin
- Death 70% to 90% methemoglobin
  - (Burrows et al., 1987; Hibberd et al., 1994).

Abortions?

- Most abortions occur after methemoglobin concentrations reach near lethal levels
  - (Davison et al., 1964; Crawford et al., 1966).

- Methemoglobin maintained at 40% to 50% for 7 months resulted no detrimental effects to pregnancy maintenance in heifers
  - (Winter and Hokanson, 1964).

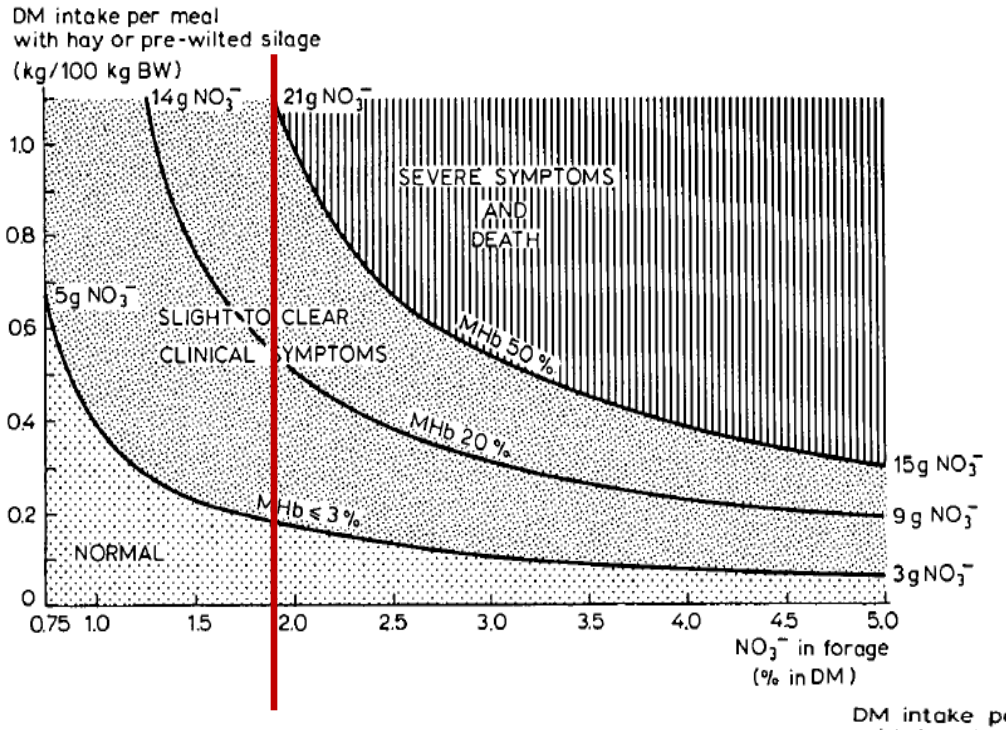
Establishing Guidelines

- LD_{50} Lethal Dose for 50% of test population
- Bradley et al., 1940
  - Drench with nitrate solution into rumen
  - Identified LD_{50} at 3,087 ppm NO_3-N
  - Suggested 2,100 ppm NO_3-N to be set as “safe” level
- Davison et al, 1964
  - Top dressed hay – 2,181 or 3301 ppm NO_3-N
  - 10% death rate (2/20 heifers) for 3301 ppm NO_3-N and increased service to conception (2.6 vs 1.3)
  - No negative effect at 2,181 ppm NO_3-N

Establishing Guidelines

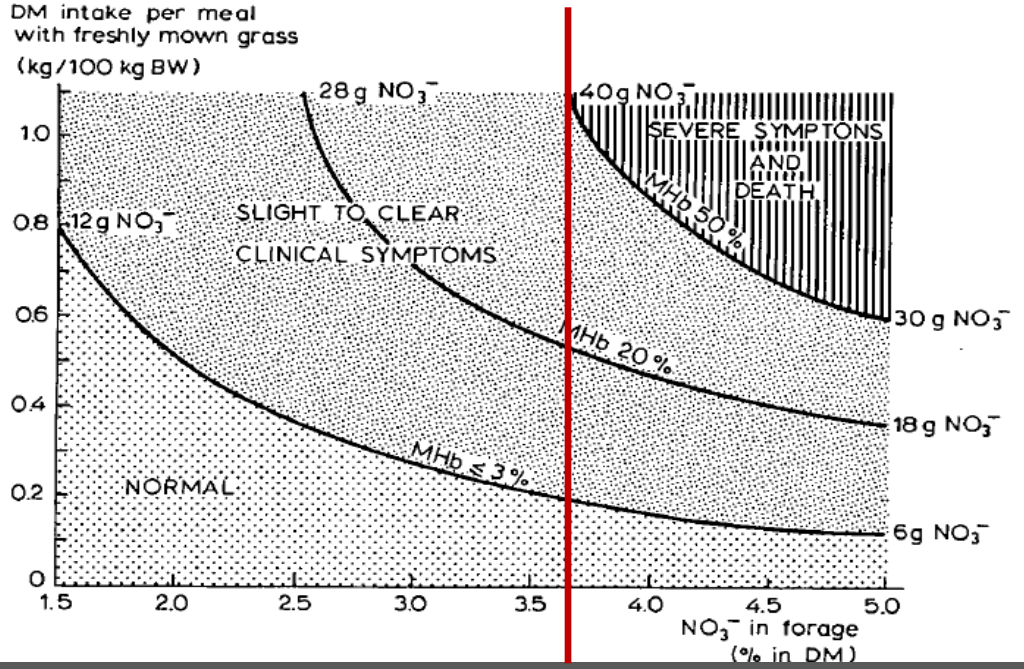
Crawford et al., 1966

- Hypothesized NO_3 in feed would reduce intake rate and increase tolerance
- Similar LD_{50} (3,040 ppm NO_3-N) when drenched
- LD_{50} at 9,119 ppm NO_3-N when dosed through hay
  - Natural in oat hay vs sprayed on hay no difference in threshold



4,400 ppm NO_3-N

8,000 ppm NO_3-N



Reprinted from Kemp, 1982

Key factors in the potential for toxicity

- Rate of intake
- Moisture content of forage
  - Rate of nitrate release (Geurink et al., 1979; Kemp, 1982)
- Microbial population
  - Up to 23,000 ppm NO_3N fed to adapted sheep (Alaboudi and Jones, 1985)
- Energy content of diet /forage quality
  - (Sapiro et al., 1949; Burrows et al., 1987)

Reynolds and Drewnoski, 2022 TAS

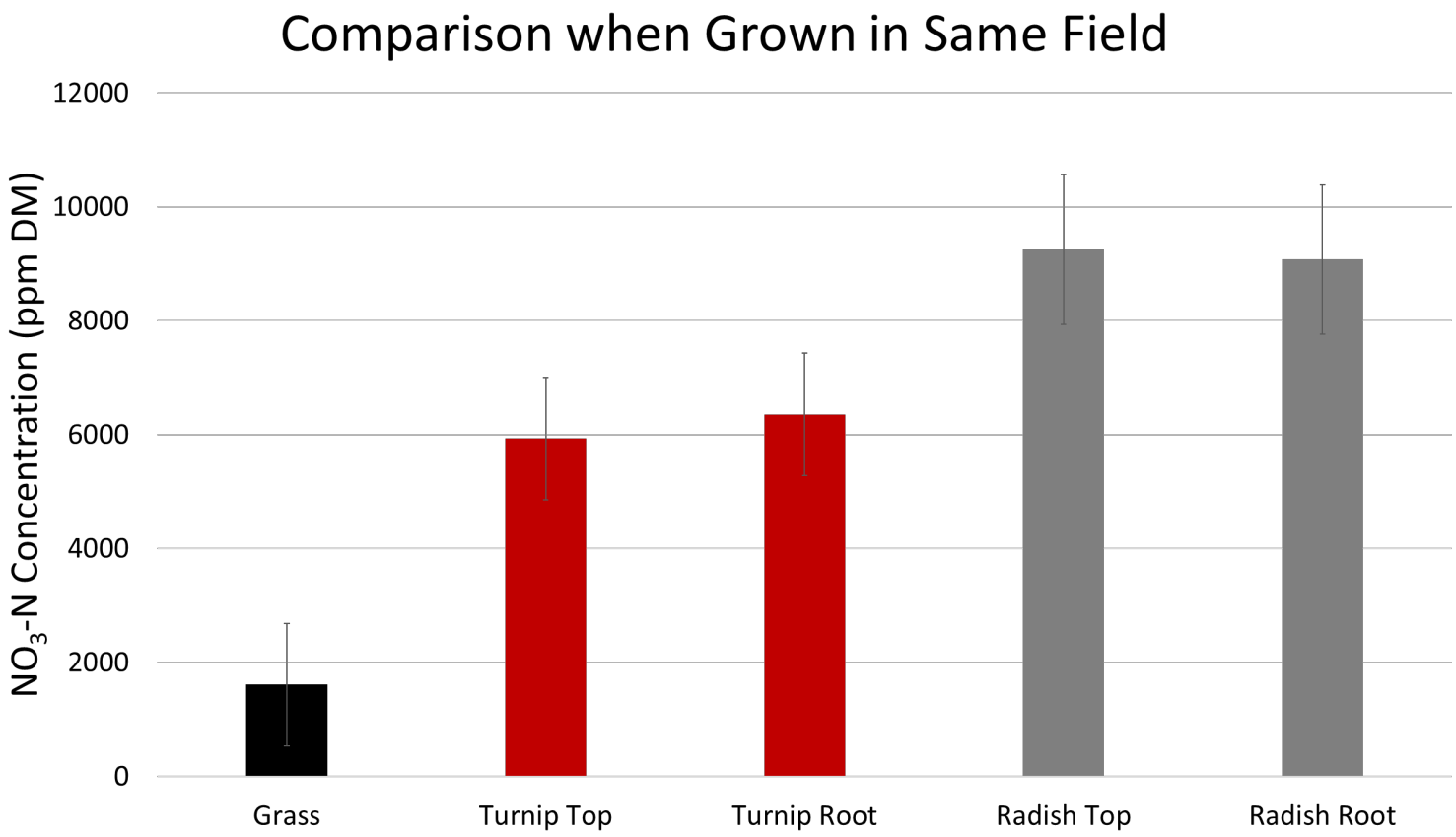
Potential mitigation factors when grazing

- Slower rate of intake
- Diet "type"
  - Fresh cells release NO_3 slower than hay
- Diet Quality
- Adaptation
  - Top-down grazing
    - Leaves < Stems in NO_3 accumulation

Grazing higher nitrate forages

- Management Strategies to Mitigate Nitrate Toxicity
  - Make sure cattle are full before turn out
  - Graze lightly
  - Adapt Gradually?
  - Supplement energy?

Brassicas: are they a problem?



Overall Implications

- Current recommendations are conservative
- Need to focus on helping producers understand what increases and decreases risk