Field Crop Fertilizer Recommendations for Alaska Forage Crops

FGV-00149A

Fertilization is an important component of forage management that impacts yield, quality and stand persistence. The purpose of this publication is to provide guidelines for forage fertilization in Alaska. Data are not presently available for all adapted forage species, but this publication will be updated when additional information becomes available. Users of this publication should be aware that recommended fertilizer rates are not optimum economic rates. Recommendations should be adjusted to your soil conditions, yield goals and production costs.

Species Adaptation

Forage species differ in their tolerance to soil conditions. Table 1 contains information regarding pH and moisture tolerances of 15 different forage species. Tolerance and productivity are not necessarily the same. A crop like smooth

Table 1. Soil pH and moisture tolerances[a] of selected forage species.

Species	pH	Soil[b] Drainage	Notes on Fertility
GRASSES			
Perennial			
Timothy	5.0 – 7.0	w-d to wet	
Smooth bromegrass	5.7 – 7.0	w-d to dry	N very important, crop can become sodbound[c] at low N
Kentucky bluegrass	5.0 – 7.0	w-d to dry	
Red fescue	5.5 – 7.0	w-d to wet	
Bluejoint	4.0 – 7.0	w-d to wet	Tolerates low fertility very well
Annual			
Oats	5.0 – 6.5	well drained	
Barley	5.7 – 7.0	well drained	
Ryegrass	5.5 – 7.0	w-d to wet	
OTHER ANNUALS			
Brassicas — rape, turnips	5.5 – 7.0	well drained	N and P both important. At low pH, P fixation can severely limit yields
LEGUMES			
Annual			
Vetch	5.0 – 7.0	w-d to wet	
Peas	5.5 – 7.0	well drained	
Sweetclover	6.5 – 8.0	w-d to dry	
Perennial			
Red clover	5.5 – 7.0	w-d to wet	K essential for winter survival
Alsike clover	5.0 – 7.0	w-d to wet	"
Alfalfa	6.0 – 7.0	w-d to dry	"

a Crops will tolerate the indicated ranges; the table is only a guide to select species that have potential for a given site. Profitability for a given crop is ultimately defined by yields and input costs.

b Soil drainage is characterized as wet, well drained (w-d), or dry.

c Sodbound describes the unproductive condition that results when high amounts of organic matter accumulate in the sod. Nitrogen is tied up by microorganisms that decompose the organic matter, so higher than normal rates of N are required to obtain normal yields. Grass species differ in their tendency to become sodbound.

Table 2. Fertilizer recommendations for forage crops grown in Southcentral Alaska under dryland conditions[a]

Forage Species	Yield Goal[b] T/a	Timing	N	P_2O_5[c]	K_2O	S[d]
			Broadcast Fertilizer Rates			
Perennial forage grasses			lb/a			
Timothy		P[e]	60	40	30	32
Smooth bromegrass	2 to 3	MS	80	60	120	
Reed Canarygrass		M1	60	30	30	32
Bluejoint (native)	1 to 2	MS	100	60	60	—
Annual forage crops						
Cereals						
Oats	3	P	60	80	60	—
Barley	3	P	60	80	60	—
Fodder rape	3 to 4	P	100	50	50	—
Ryegrass						
heading type	3	P	100	100	60	—
vegetative type	2	P	30	60	60	—
		AFC	40	—	—	

[a] **General recommendations only.** For specific recommendations in your area, contact the Cooperative Extension Office.

[b] Hay yield, 85% dry matter

[c] **Note:** ON NEWLY CLEARED LAND increase P_2O_5 rates by 50%.

[d] Required on Kenai Peninsula fields receiving historically high urea rates (total nitrogen to sulfur leaf tissue analysis recommended).

[e] Notes on timing:
P — at planting
MS — established stand, spring
M1 — established stand, after first cutting
AFC — after first cut

Table 3. Fertilizer recommendations for forage crops grown in Interior Alaska under dryland conditions[a]

Forage Species	Yield Goal[b] T/a	Timing	N	P_2O_5	K_2O	S
			Braodcast Fertilizer Rates[c]			
Perennial forage grasses			lb/a			
		P[d]	60	60	30	10
Smooth Bromegrass — 2 cuts	2+	MS	60	40	20	10
		M1	60	—	—	—
Timothy — 1 cut	1 – 1.5	MS	80	30	15	10
Bluegrass						
Hay				(same as brome)		
Seed	300 – 350 lb/a	MS	100	60	60	20
Bluegrass or red fescue						
Pasture (Delta Bison Range)			70	30	15	10
Annual forage crops						
Cereals						
Hay or silage	2+	P	90	40	20	10
Fodder rape or turnip	3+	P	100	50	20	10

[a] **General recommendations only**. For specific recommendations in your area, contact the Cooperative Extension Office.

[b] Hay yield, 85% dry matter

[c] Fertilizer rates apply primarily to agricultural land at Delta Junction and Eielson.
Note: ON NEWLY CLEARED LAND - increase P_2O_5 rates by 50%.

[d] Notes on timing of fertilizer application:
P - applied at planting
MS - established stand, spring
M1 - established stand, after first cutting

bromegrass will survive a drought but cannot be considered drought productive. Site limitations (moisture and pH) can be corrected, but species selection may reduce or eliminate the need to amend the soil. The information in Table 1 can be used to select species that have a high probability of success on a given site or to determine how much soil amendment is necessary for a given crop. Soil amendments are expensive in Alaska, so a careful, realistic cost/benefit analysis should be an important consideration in any decision to alleviate soil limitations.

Forage Quality

Soil fertility can have both direct and indirect effects on forage quality. The nature of the effects depends on the fertilizer element. Nitrogen (N) promotes rapid growth, and frequent N application will result in a dilution of minerals other than N in plant tissue. Fertilizing with other elements usually increases the concentration of those elements in the forage.

Indirect effects of fertility relate to plant growth and development. As plants mature, forage quality declines. Various elements affect forage growth and development. Abundant N promotes vegetative growth (high digestibility, low fiber) and increases crude protein (CP) concentrations. Excess N may reduce quality by causing an increase in nitrate levels. In contrast to N, adequate phosphorus (P) levels promote reproductive development, while P deficiency causes plants to flower prematurely. Potassium (K) deficiency is one cause of lodging in cereal crops.

Fertilizer Rates

Fertilizer recommendations are presented in Tables 2 and 3 for Southcentral and Interior Alaska.

Some special considerations exist and are listed below. For specific recommendations, contact the Cooperative Extension Service agent in your area.

- Nitrogen rates for oat hay or silage on the Kenai Peninsula should be limited to 40 to 50 lb N/a. Higher rates increase the risk of lodging.
- Oat lodging may also occur in other areas when the crop is harvested at advanced maturity and for tall varieties.
- Specific recommendations have not been included for forage legumes because little information is available for Alaska conditions. Potassium nutrition is particularly important for perennial legumes. Applying at least 100 to 150 lb K_2O/a is necessary for these crops.
- The recommendations in the tables are general. Some adjustment will be necessary to account for location differences. Newly cleared land should receive higher rates of P_2O_5 (see footnotes in tables).

Nitrate Toxicity to Livestock

Nitrates are not directly toxic to animals but are converted to toxic nitrites within the animal. Hemoglobin carries oxygen in the blood. Nitrites are toxic because they are rapidly absorbed into the blood and convert hemoglobin to methemoglobin. Methemoglobin cannot transport oxygen, so animals suffer a lack of oxygen and could die of asphyxiation.

Table 4 contains criteria regarding safe forage feeding at different nitrate levels. There are different ways of reporting forage nitrate concentration (nitrate-N, nitrates or potassium nitrate). Safe levels vary for each method. It is essential to know how nitrate concentration is reported in order to interpret a lab analysis. The data in Table 4 are reported as nitrate-N and the following conversions should be used when appropriate.

Nitrate-N * 4.43 = Nitrate
Nitrate-N * 7.22 = Potassium Nitrate

Abbreviations: Nitrate-N = NO_3-N; Nitrate = NO_3; Potassium Nitrate = KNO_3

Table 4. Nitrate-N concentrations and animal health

Nitrate N		Comments
%	ppm	
0 – 0.15	0 – 1,500	Considered safe, but sublethal doses may affect animal health — unknown effects
0.15 – 0.45	1,500 – 4,500	Safe to high risk. Limit to ½ of ration DM.
0.45+	4,500+	Potentially toxic.

Source: Olson, O.E. et al. 1976. *Forage Nitrate Poisoning*. South Dakota Cooperative Extension Service Publication FS 420.

Nitrate Accumulation in Plants

A variety of factors contribute to nitrate accumulation by plants. While high-risk situations can be identified, it is difficult to predict nitrate levels in feed crops. Producers should be aware of environmental conditions and management practices that favor nitrate accumulation in crops. In general, plants take up nitrates whether they are actively growing or not. Nitrates tend to accumulate when growth is limited by temperature, moisture or nutrient stress and there is an abundant supply of nitrate in the soil.

Management Factors and Nitrates

Species

Nitrate accumulation differs in species and varieties. High nitrate levels can occur in grasses (brome, timothy, etc.), cereals (oats, barley, wheat), brassicas (rape, turnips, kale) and in many species of weeds. Varietal differences exist, but these are generally small. In some cases, varieties may actually be different species. Tyfon and Winfred are both called fodder rape, but both are hybrids and rape (*Brassica napus)* is not a parent of either variety. Tyfon is a cross between turnip and Chinese cabbage and Winfred is a cross between turnip and kale. Winfred has the potential to accumulate very high nitrate concentrations under Alaska growing conditions.

N Fertilization

Nitrogen fertilization is an important factor in nitrate accumulation. Fertilizer, manure and soil organic matter all contribute to a nitrate reservoir for plant uptake. Caution should be exercised to avoid excess N application when both fertilizer N and manure are applied to a crop.

Harvest Management/Forage Utilization

Nitrate accumulation in many plants is cyclical. Nitrate levels generally decline as plants mature because nitrates are diluted as fiber accumulates and the nitrates are used for protein synthesis. Harvest at an early growth stage is desirable if high digestibility and crude protein are needed. Forage that is harvested early should be tested for nitrates if management, soil or weather conditions favor nitrate accumulation.

The form of utilization may affect nitrate concentrations slightly. Ensiling sometimes reduces nitrate concentrations when compared to hay and pasture. Under certain conditions, forage nitrates can be converted to nitrogen dioxide (NO_2), a deadly gas. NO_2 formation usually occurs during the first one to three days of fermentation.

Environmental Factors and Nitrates

Moisture

Drought is frequently linked to nitrate poisonings because moisture stress disrupts normal plant growth. Plants may continue to take up nitrate, but since the plant is not growing (making protein) the nitrates are not used and accumulate.

Temperature

Plant species differ in temperature responses. When temperatures do not favor rapid growth there is a risk of nitrate accumulation. Growth can be limited by low or high temperatures.

Light

Light intensity and duration can influence nitrate concentrations. High light intensity results in low nitrate levels, so the lowest nitrates occur on bright, sunny days. The daily, or diurnal, cycle is also related to the light, with low levels observed during the day and the highest levels observed at sunrise.

Soils

Soil organic matter (OM) is a potential source of N for plants. Producers should monitor nitrate levels of crops grown on high OM soils. High nitrate levels in the forage may indicate that fertilizer or manure rates should be reduced. However, organic matter cannot be considered by itself. Nitrate accumulation can be several times higher when soils are P deficient than when P is adequate.

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