Grass Management for Dry Dairy Cows[1]

Jerry H. Cherney
Department of Soil, Crop & Atmospheric Sciences

Debbie J.R. Cherney
Department of Animal Science
Cornell University

In Canada and the USA, potassium (K) concentration in perennial grass forages is considerably more important than nitrogen (N) or crude protein (CP) content, when used as dry cow forage. Many dairy farms are in a state of potassium surplus, and use perennial grass both as a manure sink and as dry cow forage. This results in potentially severe problems in properly managing potassium content of dry cow rations. A tactical solution to this problem is to manage 10 to 15% of your forage production specifically for dry cow forage. We have ongoing perennial grass experiments at several sites in New York state investigating proper grass species and variety selection, cutting management, as well as N and manure management necessary to produce an adequate supply of low K grass for dry cows. This is a summary of our results to-date, and concerns grass that will be mechanically harvested and stored, as opposed to grazed grass. A more extensive summary of grass for dry cows is currently in progress.

Species/Variety Selection

For New York State, a World Wide Web program is available to provide site-specific forage species recommendations based on soil type and a range of intended forage uses, including forage for dry dairy cows (http://www.forages.org). The two primary factors to consider when selecting perennial forages species and varieties for dry cow forage are 1) persistence and 2) K content.

Persistence. This involves the same set of considerations as those for lactating cow grass forage. Grass species vary in their tolerance of pH and moisture extremes.
Species ranking in adaptation to poorly drained soil conditions is:
Reed canarygrass > Timothy > Tall fescue > Smooth bromegrass > Perennial ryegrass > Orchardgrass.

Species ranking in adaptation to excessively drained soil conditions is:
Reed canarygrass > Tall fescue > Orchardgrass > Smooth bromegrass > Timothy > Perennial ryegrass.

Species ranking in ability to tolerate low soil pH is:
Tall fescue > Reed canarygrass > Timothy > Orchardgrass > Perennial ryegrass > Smooth bromegrass.

The general order of grass species to consider for intensive management where overwintering of grass is of concern is:
Reed canarygrass > Timothy > Tall fescue > Smooth bromegrass > Orchardgrass > Perennial ryegrass.

---

[1] Published in 2006

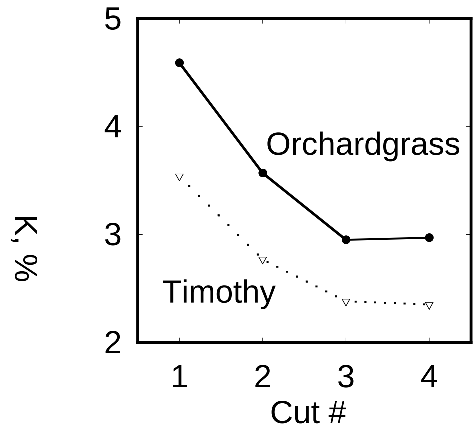

Figure 1. The typical patterns of potassium (K) content are shown for orchardgrass and timothy. If adequate soil K is available, orchardgrass will be significantly higher in K content than timothy. Potassium content almost always declines from spring to fall harvests and also declines with increased grass maturity.

Potassium content

Potassium content of perennial grasses has been reported from as low as 0.1% K up to as high as 7.0% K. Warm season grasses tend to be lower in K content than cool season grasses. Although species rankings are not completely consistent, orchardgrass tends to be significantly higher in K content at a given maturity stage than other grass species. Both orchardgrass and perennial ryegrass tend to be mineral accumulators, with high levels of K and other minerals, if there is an adequate soil supply of these minerals. Timothy on the other hand, tends to have less luxury consumption of minerals, when surplus minerals are available in the soil. Therefore, with moderate to high available soil K, orchardgrass may accumulate up to 1 percentage unit or more K than timothy. Under conditions of stress (e.g. drought) or low available soil K, the difference in K content of forage across species will be minimized. There may be some differences in K content among varieties within a grass species, but significant differences among varieties have yet to be characterized.

There may be some differences in K content among varieties within a grass species, but significant differences among varieties have yet to be characterized. Breeding for low K content has rarely been attempted in grasses. Selection may be very difficult, because there is a significant effect of environment on K uptake in grasses, compared to uptake of other minerals, such as magnesium (Mg) and calcium (Ca). Breeding for high magnesium in tall fescue, however, has been attempted. High Mg may alleviate some of the problems caused by high forage K. We are currently evaluating a high Mg tall fescue variety at Miner Institute in Chazy, NY.

Site Selection

Most soils contain large quantities of K, but very little of it is available to plants. Physical, chemical and biological processes in the soil result in release of mineral K over time. Most soil K is found in fine-grained clays, and clay content is a good indicator of the potential K-supplying power of a soil. There is a wide range in K-supplying power of soils in most regions. Organic soils, as well as sandy soils, are typically low in available K.

Soils with relatively high K-supplying power may never need any K fertilizer applied to maintain sufficient K available for grass growth and persistence. On the other hand, soils with low K-supplying power will require additional K fertilizer to avoid K deficiency in grass and reduce the risk of winter damage caused by low plant K. The amount of K released by the soil each year and made available for plant uptake varies with climatic conditions. Soil testing will identify fields with lowest soil K. These fields are prime candidates for dry cow grass management.

Stage of Maturity and Time of Season

Grass forage declines in K content with increased plant age. Plant uptake of K is very high early in the season, but later on K uptake cannot keep up with plant dry matter accumulation and is diluted out. Potassium content of orchardgrass has exceeded 4.5% in late May in our studies. Grass harvested at flowering may have half the K concentration as grass earlier in the season. Concentration of K in grasses also tends to be significantly lower in regrowth, and also lower towards the end of the growing season. As a result, the grass forage with the highest K content is usually in the spring harvest.

N and K Fertilization

Most perennial grasses harvested twice per season should maintain high yields with approximately 1.5% K in spring growth forage (harvested at flowering or later) and 1.2% K in regrowth forage (harvested in the fall). Visible K deficiency symptoms in grass will not appear until forage K content drops to around 0.8% K. Deficiency symptoms are difficult to identify and attribute to K, because symptoms are similar to those due to drought or normal senescence. Deficiency of K is seen as a yellowing and browning of dying leaf tips and margins.

Nitrogen fertilization greatly increases uptake of K, if there is sufficient K available for uptake. We have almost doubled the K content of grass through high N fertilization rates, compared to no fertilizer N applied. Recommended N applications are 75-100 lbs actual N/acre at spring greenup and 75-100 lbs actual N/acre after spring harvest. Once excessive available soil K is removed however, the opposite trend in forage K content emerges. High N fertilization produces high yields, but very low soil K availability results in very low forage K concentrations. It may take one season of moderate to high N fertilization to remove excess soil K. The forage produced the first season will likely be high in K content, but may be very low in K content in all succeeding years. After two years, soil test K dropped from “Medium” to “Very Low” (32 lb K/acre) in high N/no K stands on a soil type with average K-supplying power.

It will be difficult to impossible to produce low K grass forage on stands receiving significant manure applications. All forms of K fertilization must cease if low K grass forage is desired, until spring growth harvested near flowering drops to under approximately 1.7% K. It then may be time to consider some K fertilization, to maintain sufficient plant K for overwintering. The amount of K applied will depend on the K content of the spring harvested forage and the native K supplying power of the soil. From 50 to 100 pounds of potash fertilizer equivalent may be needed. This could come from a manure application after spring harvest. Never apply K prior to spring growth, as there should be adequate soil K released during the winter and early spring for spring grass growth. Monitoring of forage K levels will allow the production of low K forage without risking damage to the stand.

Forage Yield and Harvest Management

Five Grass Species Compared

Tall Fescue (Stargrazer), reed canarygrass (Palaton), Timothy (Tiller), smooth bromegrass (York), and orchardgrass (Artic) were sown at Ithaca in 1996 and Mt. Pleasant in 1997 to compare species under 3 rates of K fertilization with 100 lbs actual N fertilizer applied prior to each of two cuts per season. Rate of K fertilization has had a small effect on yield to-date. Average yields for 1998-1999 for Mt. Pleasant and 1997-2001 for Ithaca are shown in Table 1. Fescue and reed canarygrass tend to outyield other species. The higher elevation Mt. Pleasant site averaged 23% lower yields than Ithaca. At the Ithaca site with the deeper, soil resource, 65% of the total yield occurred in the spring, compared to 75% for Mt. Pleasant.

Table 1. Species yields under two-cut management at Mt. Pleasant (average of 1998-1999) and Ithaca (average of 1997-2001) (Both sites 4 replicates and 3 K fertilizer rates).

	Mt. Pleasant	% of Yield	Ithaca	% of Yield
	tons/acre	in 1st Cut	tons/acre	in 1st Cut
Tall Fescue	4.1	69	5.2	57
Reed canary	4.0	74	5.1	60
Timothy	3.7	77	5.0	71
S. bromegrass	3.4	79	4.1	68
Orchardgrass	3.2	76	4.2	70
Mean	3.7	75	4.7	65

Reed Canarygrass Yield and Quality

Recommended N fertilizer applications of 75-100 lbs/acre for each of two harvests will produce total yields similar to a four-harvest regime. Reed canarygrass yields for three years in Ithaca, NY are shown in Table 2. Stands (established in 1992) were fertilized to soil test recommendations for K in 1994, with no K applied in subsequent years. Stands receiving 200 lbs actual N/acre/season had reduced yields in 1997, due to very low soil K. Forage K levels for the high N treatment were under 1% K. We have produced hay equivalent yields up to 6 tons/acre with a two-harvest system on very productive soil types, with very low K content in the forage.

Forage produced in the first year in a dry cow grass management system will likely contain high K forage. Forage produced in the second year will likely be low K forage.

Table 2. Yield (tons/acre @ 12% moisture) of *Palaton* reed canarygrass harvested in mid-June and in mid-September.

N fertilizer applied per harvest	1995	1996	1997
	%DM	%DM	%DM
0	1.6	1.5	1.9
50	3.1	3.1	3.5
100	4.2	4.7	4.0

0, 50 or 100 lbs actual N fertilizer/acre applied prior to each harvest.
Stands receiving 100 lbs N/acre in 1997 showed K deficiency symptoms.

Quality of Two-Cut Dry Cow Forage

Reed canarygrass was established in 1992 and again in 1993 at two Ithaca sites. In 1995 and 1996, a two-cut management was initiated, with 3 rates of N fertilizer and 3 rates of K fertilizer. Crude protein averaged 16% for the spring harvest and 12% for the fall harvest at the high N fertilization rate in 1999 (Table 3). In vitro "true" digestibility (48-hour) declined with increased N fertilization, but remained above 70%. Neutral detergent fiber digestibility also declined with increased N fertilization, dropping to 62% in the spring and 50% in the fall at the high N fertilization rate. Neutral detergent fiber (NDF) averaged 65% in the spring and 58% in the fall at the highest N fertilization rate.

Table 3. Reed canarygrass harvested in June and September 1999 in Ithaca (average of two sites, 3 K fertilizer rates, and 4 replicates), fertilized with 0, 50 or 100 lbs actual N per acre prior to each harvest's growth. In vitro "true" digestibility (%IVTD) at 48 hours, crude protein (%CP), neutral detergent fiber (%NDF), and NDF digestibility. (HD 1 = June harvest; HD 2 = September harvest).

N fert. rate	IVTD HD 1	IVTD HD 2	CP HD 1	CP HD 2	NDF HD 1	NDF HD 2	NDF dig. HD1	NDF dig. HD 2
lbs/A	%DM	%DM	%DM	%DM	%DM	%DM	%	%
0	84	76	12.2	11.2	61	56	74	58
50	78	71	12.9	9.9	64	59	65	51
100	76	71	16.1	12.5	65	58	62	50

Withholding K fertilization reduced the available soil K to low levels in less than two years. This minimized K uptake and resulted in very low forage K concentrations. With 100 lbs actual N fertilizer per acre applied at spring greenup and after spring harvest in June, forage K content averaged 1.1% in June forage and 0.6% in September forage (Table 4). Although reed canarygrass in this study is exhibiting K deficiency symptoms, stands have survived and have been productive with adequate N fertilization. We recommend K fertilization in the form of 60-100 lbs K_20 per acre as commercial fertilizer or manure if first cut forage < 1.7% K, or stand persistence will be at risk.

Table 4. Reed canarygrass harvested in June and September 1999 in Ithaca (average of two sites and 4 replicates), fertilized with 0, 50 or 100 lbs actual N per acre prior to each harvest's growth. Forage potassium (K) content at both harvests at the 0 rate of K fertilization.

N fertilization rate	June	September
lbs/acre	K, %	K, %
0	1.4	1.0
50	1.4	0.8
100	1.1	0.6

Forage quality of grass in a two harvest system will not be of sufficient quality for lactating cows, but is sufficient for dry cows. The fiber content of grass harvested in mid to late June in New York state will be 65-70% NDF. Fiber content of regrowth grass harvested in mid to late September will be in the 50-60% NDF range. If 75-100 lbs actual N/acre are applied to each cutting, CP content of forage should be between 12-15% for both harvests. In vitro true digestibility will be around 60% for both harvests.

Feeding Grass

Hypocalcemia results from a deficiency in plasma Ca at the onset of lactation in dairy cows, and is the main cause of several severe metabolic disorders. Animal nutritionists tend to be concerned with the dietary cation-anion difference (DCAD, expressed as milliequivalents per 100 grams dietary DM) in the total ration of a dairy cow. DCAD = [(K + Na) - (Cl + S)], although more complex forms of this relationship are sometimes used. During the transition period 3 to 4 weeks prior to calving, it is desirable to have a moderately anionic diet, to avoid milk fever and hypocalcemia. Immediately after calving, a cationic diet is essential.

Although sodium (Na) content of grasses varies by species, the values are low, compared to K. Because grass has potential for very high K concentrations, K receives the most attention. It is desirable to minimize K content of grasses (K < 2%) to produce an anionic diet for dry cows. Consideration may also be given to increasing the energy content of the ration during the late transition phase, using corn silage or gain. The increased energy from these sources may help improve the cow's physical condition as well as dilute the higher K levels of other forages in the diet. Rations for dry cows based predominately on corn silage, however, are discouraged.

Summary

If perennial grass is managed specifically for production of dry cow forage, relatively high yields of low K forage are possible. Several feeding problems associated with lactating cows can be minimized if low K forage is available for dry cows.

The current prescription for grass forage for dry cows is as follows:

- Select fields that have soils with low K supplying power, if you have a choice.
- Use soil testing to identify fields with low K soil test for dry cow forage.
- Use timothy, reed canarygrass, or smooth bromegrass, and avoid orchardgrass or perennial ryegrass (although if soil K is limiting, all species may have relatively low forage K).
- Avoid all forms of K fertilization (No Manure).
- Use moderate to heavy N fertilization (75-100 lbs/acre/harvest).
- Harvest 2x/year, approximately mid-June and mid-September.
- Use grass regrowth for cows close to calving, as it should be lowest in K content.
- If K content of spring grass forage is below 1.7%, consider modest K fertilizer or manure additions after spring harvest (50-100 lbs potash or equivalent).