POTASSIUM ACCUMULATION IN PERENNIAL COOL-SEASON GRASS FORAGE

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ABSTRACT

Perennial grasses are well adapted to the northern U.S.A. and Canada, but the potassium (K) content of grass forage is a major concern in regard to dairy cattle nutrition. Our goal was to identify factors influencing potassium content of grasses, so that a grass management strategy for controlling potassium content could be formulated. Separate experiments were conducted with several perennial cool-season grass species and varieties. Nitrogen fertilization and harvest management also were evaluated. Aside from the obvious positive effect on K concentration caused by commercial K fertilizer or by animal manure application, K concentration was influenced by grass species, grass maturity, time of season and N fertilization. Orchardgrass (Dactylis glomerata L.) was consistently high in K content, while timothy (Phleum pratense L.) and smooth bromegrass (Bromus inermis Leyss.) were up to 10 g kg^{-1} lower in K concentration. Reed canarygrass (Phalaris arundinacea L.) remained high in K content until inflorescence emergence and then declined. Grass regrowth was consistently lower in K content than primary spring growth.

KEYWORDS

Forage quality, minerals, fertilization

INTRODUCTION

In the U.S.A. and Canada, K concentration in perennial forage grasses is second in importance only to nitrogen content, for grass fed to dairy cows. For non-lactating dairy cows, K content of grass is more important than N content. High K in soils reduces magnesium uptake, and results in high potassium in plants which interferes with magnesium metabolism in ruminants. High K in grasses also negatively affects the dietary cation-anion balance in ruminants.

The United States - Canadian Tables of Feed Composition (1982) list K concentration for timothy, orchardgrass, smooth bromegrass, and reed canarygrass hay at 15.2, 33.6, 22.8, and 27.6 g kg^{-1} DM, respectively. In contrast, a recent dairy feeding trial (Weiss, 1995) used orchardgrass forage with 50.1 g kg^{-1} K on a DM basis. While historically interesting, old tabular values do not relate well to K in perennial grasses under current fertilization/harvest regimes in the U.S.A. Our objective was to define the factors influencing K concentration in perennial cool-season grasses.

MATERIALS AND METHODS

Potassium concentration was monitored in several field trials with cool-season grasses to evaluate the effect of maturity, time of season, N fertilization, species, and variety. **Trial 1**: Reed canarygrass was fertilized with 0, 56, and 112 kg N ha^{-1} in early spring, and sampled weekly through the spring. **Trial 2**: Six varieties each of timothy and orchardgrass were fertilized with 84 kg N ha^{-1} in early spring and 56 kg N ha^{-1} after second and third harvest. **Trial 3**: One variety each of smooth bromegrass, timothy, reed canarygrass, orchardgrass, and tall fescue (Festuca arundinacea L.) were fertilized with 84 kg N ha^{-1} in early spring. Varieties were selected for similar heading dates. **Trial 4**: One variety each of timothy and reed canarygrass were fertilized with 0, 67, 135, 269, or 538 kg N ha^{-1} split-applied two to three times, in early spring and during the growing season. There were two harvest regimes of three or four cuts per season. **Trial 5**: A three-year-old reed canarygrass stand was fertilized with 0, 56, or 112 kg N ha^{-1} in early spring and after first harvest, with a two-cut harvest regime in mid-June and mid-September. Rates of N fertilizer also had been applied the previous two years. All field studies were fertilized with P and K as recommended by soil test results. Dry ground samples were ashed, extracted with HCl, and analyzed by atomic absorption spectrophotometry.

RESULTS

Trial 1. Potassium concentration in reed canarygrass did not change throughout May in 1994 or 1995, averaging 28.5, 31.8, and 34.2 g kg^{-1} DM for 0, 56, and 112 kg N ha^{-1} fertilizer rates. Potassium increased linearly with increased N fertilization in May. Concentration of K declined in June and averaged 22.0 g kg^{-1} by June 13, with no differences in K among the three N fertilizer rates.

Trial 2. Potassium concentration in orchardgrass varieties was considerably higher than timothy varieties (Table 1). Potassium declined significantly in regrowth, compared to spring harvest. There were no significant differences among varieties within a species.

Trial 3. Grass harvested at heading contained 23.5, 26.2, 26.4, 31.0, and 27.7 g K kg^{-1} for smooth bromegrass, timothy, reed canarygrass, orchardgrasss and tall fescue, respectively, in 1994. In 1995, grass contained 22.2, 22.3, 24.7, 23.6 and 23.5 g K kg^{-1} for smooth bromegrass, timothy, reed canarygrass, orchardgrass and tall fescue, respectively.

Trial 4. Nitrogen fertilization increased K uptake in both reed canarygrass and timothy (Figure 1) in general. This effect did not carry over beyond the cutting that received the N fertilizer, except at high N fertilizer rates. Concentration of K declined later in the growing season.

Trial 5. Potassium concentration in reed canarygrass was 21.0, 18.8 and 14.3 g kg^{-1} for 0, 56, and 112 kg N ha^{-1} fertilizer rates, respectively, for the June harvest. For the September harvest, K concentration was 13.5, 11.0, and 7.8 g kg^{-1} for 0, 56, and 112 kg N ha^{-1}, respectively. There was a significant linear decline in K concentration with increased N fertilization.

DISCUSSION

While N concentration in grasses declines consistently in the spring, K concentration in maturing grass did not decline until the end of May (Trial 1). Potassium concentration declined in regrowth harvests compared to spring growth (Trials 2, 4 and 5), agreeing with published data (Brown et al., 1969; Allinson et al., 1992). Concentration of K did not differ among varieties within a species (Trial 2), but did vary among grass species (Trials 2, 3, and 4). An exception to this is the moisture-stressed spring growth of 1995 (Trial 3), where K concentration was low and did not differ among species. Reed canarygrass plots that received a range in N fertilization rates in past years (Trial 5) exhibited a completely different pattern than other trials. Potassium content was low and declined with increased N fertilization, because soil K was lower in high N plots (data not shown), due to high K removal rates in the past. This agrees with data on K content of reed canarygrass that was fertilized with N, but not K (Allinson et al., 1992).

Based on historic and current data, it appears that timothy and smooth bromegrass forage are significantly lower in K content than orchardgrass. Varieties within a species likely do not vary in K content. Spring grass growth harvested at anthesis or later will be considerably lower in K content than less mature grass. Grass regrowth will be lower in K content than spring growth, at similar levels of fiber in the forage. The above factors can be manipulated to produce a low K forage for non-lactating dairy cows.

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Table 1
Potassium concentration in timothy and orchardgrass as influenced by harvest date in 1994[z].

Timothy[x]		Orchardgrass[y]	
Harvest Date	K[w], g kg^{-1}	Harvest Date	K, g kg^{-1}
June 3	35.4[a]	May 31	45.9[a]
July 12	27.7[b]	July 8	35.7[b]
Aug. 29	23.8[c]	Aug. 23	29.5[b]
Oct. 27	23.5[c]	Oct. 27	29.7[b]

[z]Average of four replicates and six varieties.
[y]Timothy varieties were Chazy, Climax, Mariposa, Mohawk, Richmond and Tiller.
[x]Orchardgrass varieties were Benchmark, Dawn, Haymate, Okay, Pennlate, and Axiom.
[w]Means within a column that do not have common superscripts differ ($P<0.05$).

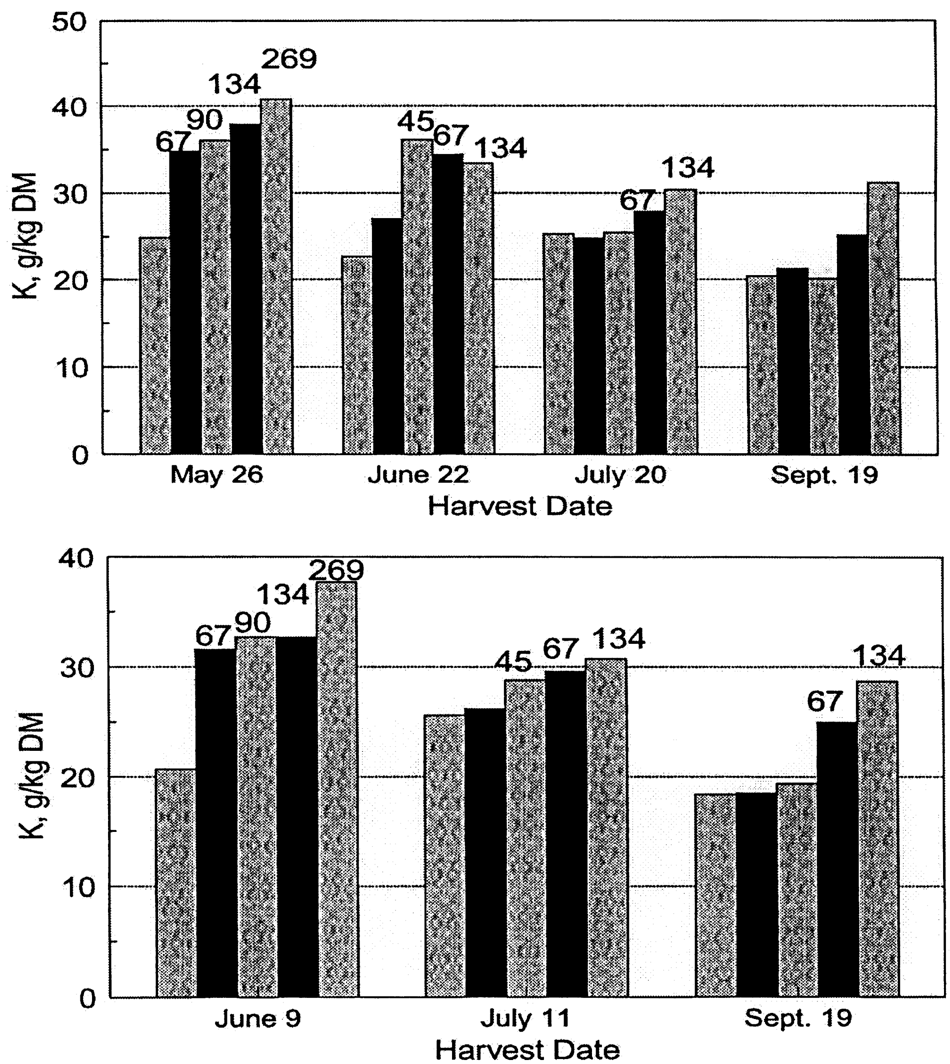

Figure 1
Potassium content of timothy forage fertilized with five rates of N and harvested either three or four times in 1994. Values above bars indicate the amount of N fertilizer (kg N ha^{-1}) applied before the harvest.