Grassland potassium balance in a pot experiment using soils with different management histories

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Aim of the study

1. Testing the hypothesis that K dynamics are not only influenced by the acutal K fertilisation but also by the previous soil K management history.
2. Investigation of K dynamics in sandy soils as these are characterised through relatively small absorption capacities for K.
3. The effects of K dynamics on Mg in Italian ryegrass (*Lolium multiflorum* Lamark).

Background

Potassium (K) is an essential nutrient in plant nutrition. Due to differences in nutrient management on farms, deficiencies and surpluses might occur with consequences for nutrient efficiency and sustainability and animal health.

High levels of K in soil might have negative impacts on the magnesium (Mg) uptake for grass resulting in low Mg intake and related metabolic issues in lactating cows.

Material and Methods

- A glasshouse experiment with a two-factorial design and four replicates:
  - 4 sandy soils of varying K input history: 1= low soil K_{CAL}, 2 = moderate, 3 = high, 4 = very high (Table 1)
  - 3 K fertiliser levels: K0 = 0 K, K1 = 30 g m^{-2}, K2 = 60 g m^{-2} as muriate of potash.
- Each pot contained 3.25 kg moist soil; N fertilisation = 12.5 g N m^{-2} for all pots as calcium ammonium nitrate.
- Harvests of roots, stubble and shoots (four cutting dates). Values of plant material refer to dry matter (105℃).
- Soils were air-dried. Plant available soil K = CAL extraction.

Results

Table 1: Potassium input, uptake and difference in plant available soil K_{CAL} of the beginning and end of the pot experiment; means and least significant differences (l.s.d.; values with different letters within columns are significantly different at $P<0.05$).

Soil	Initial K_{CAL} [mg kg^{-1}]	K treatment	K input [mg pot^{-1}]	Shoot K uptake [mg pot^{-1}]	Stubble K uptake [mg pot^{-1}]	Root K uptake [mg pot^{-1}]	Shoot Mg uptake [mg pot^{-1}]	$K_{CALend} - K_{CALbeginning}$ [mg pot^{-1}]
1	18	0	0	56 d	5 f	1.3 b	28 d	-27 c
		1	636	481 b	74 bcd	4.2 ab	37 bcd	118 c
		2	1272	516 ab	77 bc	5.3 ab	32 cd	756 a
2	93	0	0	272 c	38 e	2.8 ab	38 bc	-202 d
		1	636	625 a	75 bc	7.5 a	39 bc	-8 c
		2	1272	510 ab	83 bc	4.8 ab	32 cd	682 ab
3	168	0	0	540 ab	55 de	3.2 ab	50 a	-371 e
		1	636	583 ab	74 bcd	3.3 ab	41 abc	82 c
		2	1272	645 a	107 a	6.1 ab	43 ab	776 a
4	295	0	0	526 ab	66 cd	2.8 ab	50 a	-371 e
		1	636	530 ab	91 ab	3.2 ab	41 abc	-23 c
		2	1272	598 ab	89 ab	6.6 a	43 ab	607 b

Conclusions

1. Influencing factors:
   The concentrations of K and Mg in the shoots and stubble were significantly determined by initial soil K and K fertiliser input. Potassium fertilisation led to higher K concentrations in shoots and stubble, while only roots of well supplied soils showed higher concentrations of K in roots at the highest K input level.
2. Soil K dynamics:
   Soils 3 and 4 released substantial amounts of K for plant uptake at a moderate N fertilisation even when no K was applied. The control treatment of soil 1 with a low level of soil K had a much reduced capacity for providing K. Mining of K has taken place in soil 1 under a management with very limited nutrient return for some time.
3. Effects on K dynamics on Mg in Italian Ryegrass:
   Magnesium concentrations in shoots were reduced with higher K input and at higher initial soil K level.