POTASSIUM

Key points

- Soil testing is a very effective means of determining potassium requirements.
- Potassium export in crops, milk or meat must be accounted for when calculating nutrient budgets.
- Potassium deficiency symptoms first occur in the older leaves of plants, and can be mistaken for disease infections.
- Dairy shed effluent applied to paddocks can result in excess soil potassium and potential animal health problems.

Background

Potassium (K) is one of the essential nutrients in plants and is one of three nutrients (including nitrogen and phosphorus) that are commonly in sufficiently short supply in the soil to limit crop yields on many soil types in Tasmania. Compared to other nutrients plants need relatively large amounts of K and over the years many soils have been depleted of K because of K removal in farm produce. Potassium has many functions including the regulation of the opening and closing of stomata which are the breathing holes in plant leaves that regulate moisture loss from the plant. For this reason K is known as the poor man's irrigation because it can help crops tolerate dry spells.

Soil sampling and diagnosis

Soil and plant analysis give insight into the availability of K in the soil. Research has shown that the concentration of extractable soil K for optimum production of potatoes and pastures varies with soil texture (Table 1). However, no such dependency has yet been shown in cereals which have a lower soil K need than do dicotyledonous plants (Table 1).

Table 1. *Tasmanian optimum agronomic soil potassium (Colwell, mg/kg)* levels *for pastures. (Gourley et al. 2007; Chapman et al. 1992; Maier et al. 1986; Brennan and Jayasena 2007; Wong 2000; Gourley 1999).*

Soil texture	Pasture 0-100 mm	Potato 0-150 mm	Cereal 0-100 mm
Sand	121 - 170	200	50
Sandy/silty loam	151 - 220		
Sandy clay loam	151 - 220		
Clay loam & clay	171 - 250		

The availability of K may be affected by soil type and the ability of the plant to acquire sub-soil K (Edwards 1993). Deep-rooted species can make use of such K.

Soil test results can vary within paddocks due to differences in soil type and in paddocks that have hump and hollow drainage installed. Fertiliser K freshly applied to the tops of humps can be washed in surface runoff to the hollows (Cotching 2000). Practices such as burning of windrowed crop stubbles can concentrate K in particular parts of a paddock. For these reasons growers should use soil test results in conjunction with plant tissue testing and visual symptoms to determine application rates for paddocks.

Potassium lost through product removal should be replaced. Removal rates for each crop differ, and this must be accounted for when budgeting K requirements for the coming season (Table 2). When removal rates of K by potato and poppy crops were compared to fertiliser application rates on Tasmanian soils, K fertiliser rates on poppies and potatoes were found to be mostly at, or close to, maintenance K rates (Sparrow *et al.* 2003). Large amounts of K are applied to potato crops but potatoes remove much of this.

Table 2: *Potassium removed in various crops (kg / tonne of produce).*

Crop	Potassium removed (kg)
Wheat	4
Barley	5
Oats	5
Canola	9
Lupins	10
Grass hay/silage	17 (dry matter)
Grass pasture	40 (dry matter)
Potato tubers	6
Milk	1.4

Potassium deficiency or excess

Most soils in Tasmania are prone to K deficiency, and pasture legumes are particularly susceptible to, and can be affected by, K deficiency when cereal yields remain unaffected. Unless plant symptoms are recognised, or soil or tissue testing done, the first signs of K deficiency in a paddock may be poor growth and a gradual disappearance of the pasture legume component.

Small amounts of K are exported in farm products but the quantity of K within dairy effluent is high and will vary with feed type and quantities. Minimal K is lost throughout collection and conveyance of dairy effluent on the farm, and it can be assumed that most K collected will be available for reuse. Transporting of hay and silage around the farm and feeding these out on different paddocks to those from which it has been harvested can also result in high soil K levels on some paddocks.

Excessive soil K levels can result in high K uptake by pasture, thus increasing K intake by animals (Hosking 1986, Judson and McFarlane 1998) that can increase the risk of stock health problems, notably calcium deficiency (milk fever or hypocalcaemia) and magnesium deficiency (grass tetany or hypomagnesaemia. The high K concentration in pasture suppresses the uptake of calcium and magnesium by stock, leading to low concentrations of each in the cow's bloodstream. Dairy cows are most susceptible to high K levels in the diet during the transition period (before calving) and early lactation. Not grazing cows on areas where dairy effluent has been applied during these times, particularly on consecutive days, will minimise the risk of grass tetany. In addition, grazing the pasture when ryegrass has reached the three-leaf stage is recommended, because the concentrations of Ca and Mg will have increased in the plant by that stage. Increasing the proportion of legume in the pasture will also increase the concentration of Ca and Mg in the animals' diet. Late winter is a risky time because pastures then tend to be grass-dominant. Magnesium oxide can be added to stock feed to reduce the risk of grass tetany. To minimise the risk of grass tetany and milk fever, annual applications of K should be based on representative soil test results plus a whole farm nutrient budget.

Visual symptoms of deficiency

Potassium is highly mobile in the phloem and can be moved to newer leaves if the nutrient is in short supply, with deficiency symptoms appearing first on older leaves. General symptoms initially include a light green to yellow colour of the older leaves. Marginal scorch of the edges and tips of these leaves follows, often resulting in senescence. As the severity increases, this condition progresses towards the top of the plant. These characteristic symptoms of K deficiency can often be mistaken for leaf diseases such as yellow spot and *Septoria nodorum* blotch in wheat or brown leaf spot in lupins. Other symptoms include slow plant growth, weak stems and lodging, high screenings levels in the harvested grain and reduced disease resistance.

Fertiliser types

Muriate of potash (MOP - KCl; 49.5% K) is the cheapest form of K and is applied by top dressing either before seeding or up to 5 weeks after seeding. Sowing MOP directly with the seed can significantly reduce crop germination and establishment, with rates of MOP higher than 30 kg/ha (22 cm row spacing) affecting germination significantly. Sulphate of potash (SOP) is a less damaging form of potassium and can be drilled with seed. This product is significantly more expensive than MOP per unit of K.

Further reading and references

Brennan, RF and Jayasena KW (2007) Increasing applications of potassium fertiliser to barley crops grown on deficient sandy soils increased grain yields while decreasing some foliar diseases. *Australian Journal of Agricultural Research* 58, 680-689.

Chapman KSR, Sparrow LA, Hardman PR, Wright DN, Thorp JRA (1992) "Potassium nutrition of Kennebec and Russet Burbank potatoes in Tasmania: effect of soil and fertilizer potassium on yield, petiole and tuber potassium concentrations, and tuber quality". *Australian Journal of Experimental Agriculture* 32, 521-7.

Cotching WE (2000) Nutrient runoff from a dairy pasture on a hump and hollow drainage system at Togari, north west Tasmania. *Natural Resource Management* 3(2) 18-24.

Edwards NK (1993) Distribution of Potassium in the soil profile of a sandplain soil under pasture species. In "Plant Nutrition - From Genetic Engineering to Field Practice". (ed. NJ Barrow) pp 609-12. (Kluwer Academic: The Netherlands).

Gourley CJP, Melland A, Waller R, Awty ID, Smith A, Peverill K, Hannah M (2007) Making better fertiliser decisions for grazed pastures in Australia. Victorian Government, Department of Primary Industries, Melbourne.

Hosking WJ (1986) *Potassium for Victorian Pastures - A Review*, Department of Agricutlure and Rural Affairs, Victoria, Victoria.

Judson GJ and McFarlane JD (1998) Mineral disorders in grazing livestock and the usefulness of soil and plant analysis in the assessment of these disorders. *Australian Journal of Experimental Agriculture 38, 707-723.*

Sparrow LA, Cotching WE, Hawkins K (2003) Fertiliser practices of Tasmanian potato and poppy growers: do they show any relation to pre-plant soil test information? In 'Tools for nutrient and pollutant management: Applications to agriculture and environmental quality.' pp. 205-212. (Eds LD Currie, JA Hanly) Occasional Report No. 17. (Fertilizer and Lime Research Centre, Massey University: Palmerston North, New Zealand).

Wong MTF, Edwards NK, Barrow NJ (2000) Accessibility of subsoil potassium to wheat grown on duplex soils in the south-west of Western Australia. *Australian Journal of Soil Research 38, 745-751.*

Yeates J (2006) Potassium deficiency in pasture legumes. Department of Agriculture and Food, Western Australia Farmnote 77/86. (online)

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