The importance of potassium in soils and plants

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Potassium, one of the three major plant nutrients nitrogen, phosphorus and potassium

Potassium is found in all living cells and is essential for them to function properly.

Potassium exists in soils, plants, animals and humans as the ion K^+ (a cation).

Potassium has two roles in plants.

1. Activation of enzymes involved in metabolic processes especially those producing proteins and sugars – biochemical function – small amounts required, no other element can replace potassium

2. Maintaining the water content of crops – biophysical function – large amounts required, can be replaced if soil deficient in potassium but potassium is the "plant preferred" nutrient in this role

Potassium and its biophysical role

In plant leaves carbon dioxide from the atmosphere is converted to sugars using the energy from sunlight.

These sugars are used initially to increase plant growth. Then

for grass continuous leaf growth is the aim.

for arable crops the aim is to get the maximum saleable yield.

For leaves to work efficiently the largest possible area must be exposed to sunlight.

To achieve this exposure every living cell in the leaf has to be turgid (rigid, swollen).

Potassium is the "plant preferred" cation to maintain the turgor (rigidity) of all cells.

Nitrogen and potassium interactions and crop production

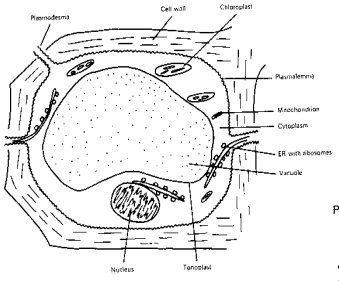
To achieve optimum yields plants have to produce a full leaf canopy (ground cover) as quickly as possible.

This is done by applying nitrogen.

Nitrogen works by stimulating cell division – producing more cells - and by increasing cell size.

More and larger cells mean more water in the crop.

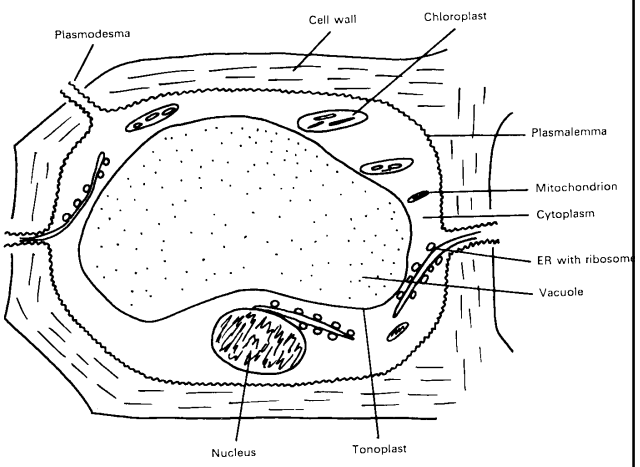
More and larger cells with more water require more potassium to maintain turgor.



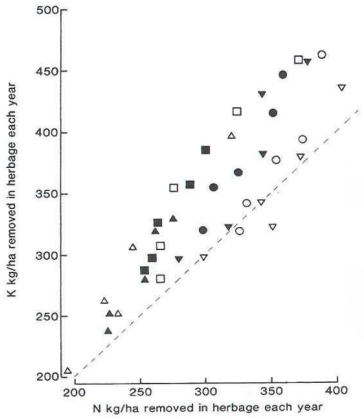
Increasing cell length 2-fold increases cell volume almost 8-fold and greatly increases cell water content

Difference in water content between crops well and poorly supplied with N

Cereals, 10-15 t/ha
Sugar beet 30-35 t/ha



Nitrogen and potassium interactions

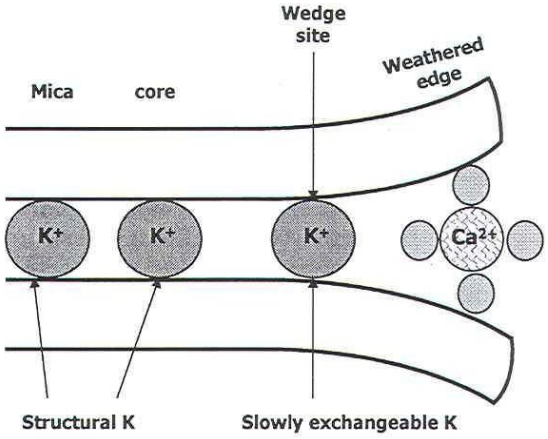


Grass contains more K than N

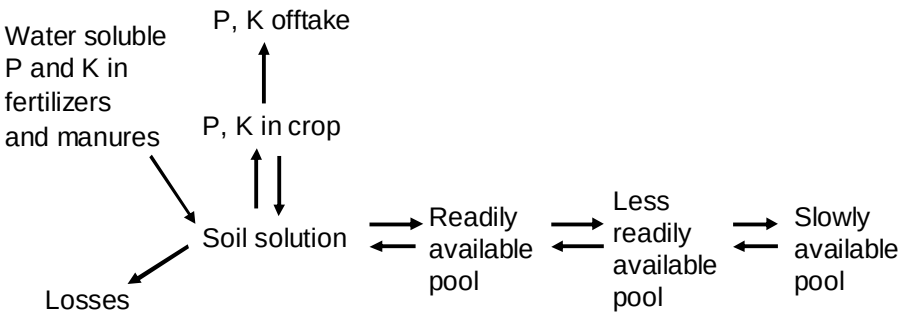
Effect of K on canopy development of sugar beet given standard N application

Current concepts about the behaviour of potassium in soil

Slowly exchangeable K on wedge sites



Current concepts of the behaviour of P and K in soil

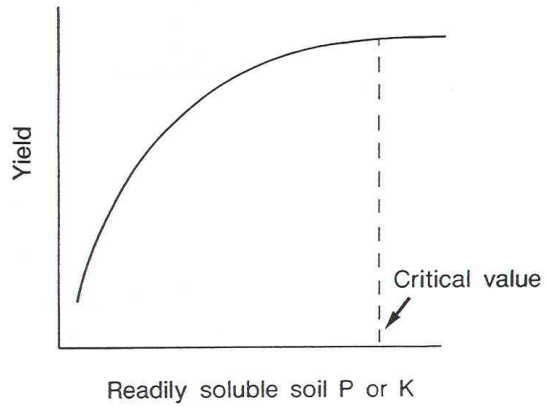


Soil analysis measures P and K in the soil solution and the readily available pool

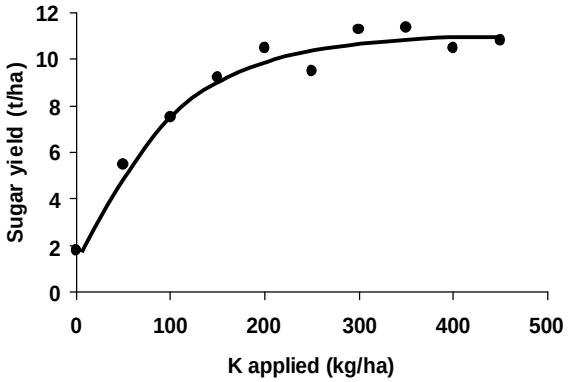
Potassium balances and changes in exchangeable K Garden Clover experiment, Rothamsted

Period	K, kg/ha applied annually	Total K balance kg/ha	Change in Kex in the period in kg/ha	as % of K balance
1956-66	none	-246	+23	-
	136	+617	+260	+42
1968-78	250	+1667	+690	+41
1979-83	125	-1494	-563	-38

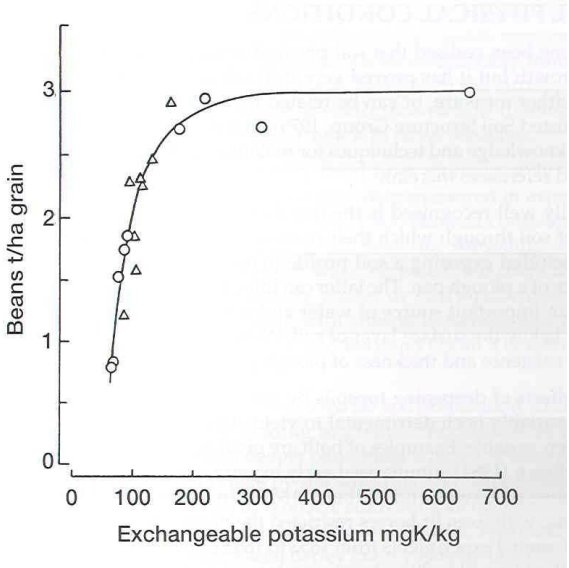
How much P and K should there be in the readily available pool?



Relate yield to applied potassium



Relate yield to exchangeable potassium in soil



Yields of herbage from permanent grass and response to nitrogen and potassium, 1965-68

		K_2O, kg/ha, applied annually			
		0	140	270	540
Kex	N				
mg/kg	kg/ha[1]	Yield, t/ha			
80	40	5.8	6.9	6.8	6.7
80	80	6.5	8.3	8.6	8.0
670	40	8.5	9.0	8.6	8.2
670	80	11.8	12.0	12.1	12.2

[1]N applied for each harvest

Effect of exchangeable K on the efficiency of nitrogen use by spring barley

	N applied, kg/ha			
	0	48	96	144
Kex, mg/kg	Yield grain, t/ha			
60	1.8	3.1	3.1	2.9
340	1.9	3.9	4.9	5.0

Effect of Kex on the efficiency of nitrogen use by winter wheat

Kex, mg/kg	N applied, kg/ha, in spring 120	160	200	240
	1st wheat following winter beans, t/ha, 1983/84			
106	9.66	9.22	9.29	10.33
133	10.98	11.38	11.29	11.26
	2nd wheat following wheat 1983/84, t/ha, 1984/85			
106	8.53	8.67	8.39	8.79
133	9.28	9.68	8.99	9.28