AGRI-FACTS
Practical Information for Alberta's Agriculture Industry

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Potassium Fertilizer Application in Crop Production

Potassium (K) is required by all plant and animal life. Plants require potassium for photosynthesis, osmotic regulation and the activation of enzyme systems. Potassium deficiency in cereal crops results in reduced growth, delayed maturity, lodging caused by weak straw, and low bushel weight.

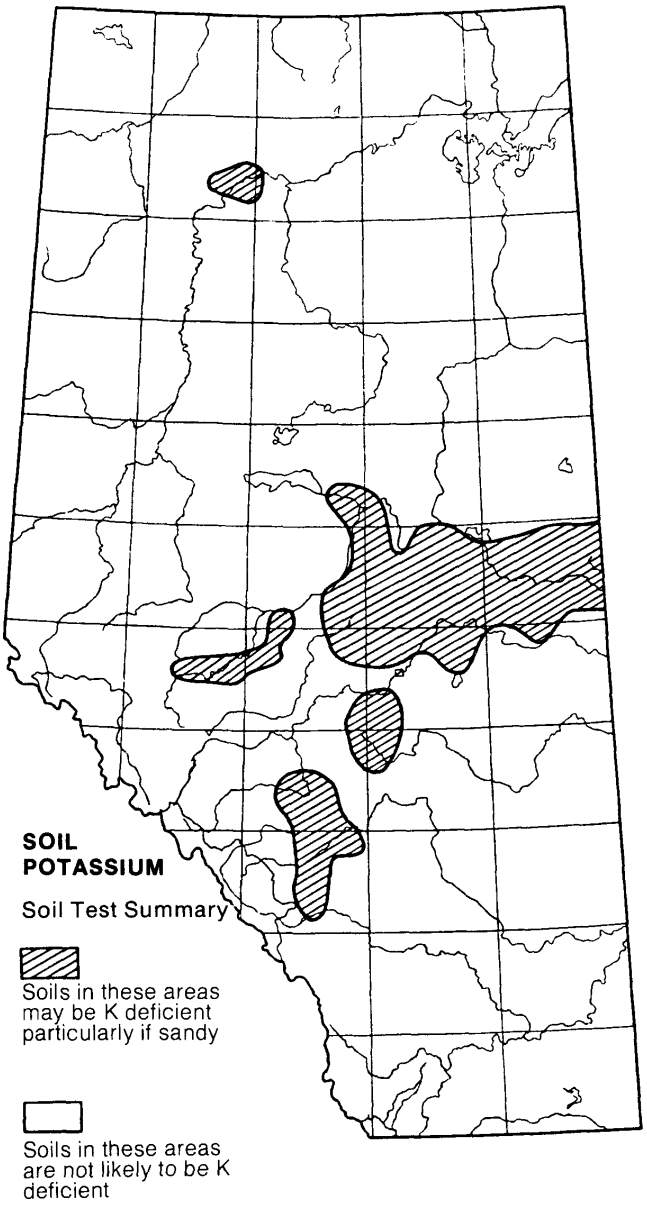
Potassium deficiency

Potassium deficiency **symptoms** on cereal grains appear as a burning or scorching of the lower leaves. The burning begins at the tip of the leaf and continues down the leaf margin. Lower leaves are affected first because potassium in the plant is transported to the new upper leaves. Potassium deficiency in alfalfa appears as white or yellow spots on the lower leaves. Many other factors can affect the appearance of lower leaves, so diagnosis based on deficiency symptoms is risky.

Potassium deficiency in Alberta is less common than nitrogen, phosphorus or sulphur deficiency for several reasons. First, the parent geologic material on which the soils developed generally contained considerable potassium-bearing minerals. Secondly, the soils are young and have undergone minimal weathering and leaching. Thirdly, crop removal has been relatively minor where cereals have been the dominant crop, especially where straw was left on the field or manure returned to it.

There are an estimated **3 million acres** of potassium deficient soils in Alberta. Of this total, about 2.5 million are moderately deficient and **0.5 million very deficient**. Potassium deficient soils tend to be light to medium textured, alkaline, carbonated and imperfectly to poorly drained in their natural state. Organic soils are also frequently deficient in potassium.

Potassium chloride (KCl), also called **muriate of potash**, is the most commonly used potassium fertilizer. It is a relatively inexpensive nutrient, and deficiencies can often be corrected with



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moderate rates of application. As a result, correcting a potassium deficiency can result in excellent economic returns.

Potassium requirements of crops

The potassium content of the above-ground portion of commonly grown crops is shown in Table 1. Note the distribution of potassium between grain and straw as compared to nitrogen and phosphorus. Potassium removal from the soil is relatively low when only the grain of cereals is removed from the field. Potassium removal is much higher when forage crops or potatoes are grown. If the forage is fed to livestock on the farm, the manure can be used to return much of the potassium removed by the forage crops.

While an awareness of the amount of potassium removed by various crops is useful, it is not in itself a basis for determining fertilizer requirements. The majority of soils in the prairie region contain high levels of available potassium and can supply adequate amounts, even for high-use crops, for many years. On soils marginal to deficient in potassium, high use crops will require higher rates of potassium fertilizer to maintain adequate nutrition.

Table 1. Nutrient uptake of crops for specific yields (pounds/acre)

	Yield			N		P_2O_5		K_2O	
	(bu)	grain	straw	grain	straw	grain	straw	grain	straw
Wheat	(40)	2400	3600	60	25	25	6	15	70
Barley	(60)	2900	3500	60	25	25	6	20	75
Canola	(30)	1500	3000	60	35	30	12	15	65
Flax	(20)	1100	2300	40	15	17	6	15	35
	Tubers								
Potatoes	30000			100		50		150	
	Hay								
Alfalfa	4000			120		20		110	
Grass	4000			80		20		80	

Determining the need for potassium fertilization

The easiest way to determine the need for potassium fertilization is through a soil test. In Alberta, response to potassium fertilizer has been related to the amount of potassium extracted from the soil with ammonium acetate. Results of potassium fertilizer research with barley in central Alberta are shown in Table 2.

Large increases in barley yield were usually obtained when potassium fertilizer was applied to soils with less than 151 lb/ac of extractable potassium. On soils with 151 to 250 lb/ac of extractable potassium, moderate fertilization (15 to 30 lb/ac of K_2O) usually resulted in a profitable response.

Table 2. Yield response of barley to potassium fertilizer at different soil extractable K levels (Lacombe Research Station and ADA data)

Soil Extractable-K (lb/ac in the 0-6 in. depth)	No. of Sites	Average Increase in Yield (bu/ac)
less than 101	17	25.8
101 - 150	21	12.1
151 - 200	18	5.2
201 - 250	8	5.9
greater than 250	34	3.4

Response to potassium fertilization is sometimes obtained on soils not considered deficient in potassium. Research, principally in Oregon, Washington and South Dakota, has shown that the presence of chloride in potassium chloride can result in increased yield through the suppression of plant diseases such as take-all and common root rot. Such responses cannot be predicted at this time. Therefore, the use of potassium chloride on non-potassium deficient soil for the suppression of disease must be on a trial and error basis.

Research in Montana has indicated that potassium deficiency may occur on soil with high soil-test potassium because of slow potassium diffusion in cold, dense soils. These results have been used to promote the need for potassium fertilization for early seeding of cereal crops in central and northern Alberta.

Research in Alberta on potassium deficient soils has shown equal response of barley to potassium with early and late seeding. If soil potassium was less available at lower soil temperatures, greater response to potassium should have been obtained with early than with late seeding. The results do not support a great potassium requirement for early seeding.

Choosing the rate of application

The soil test benchmarks for major crops in Alberta are shown in Table 3. The rate of application is based on the soil test level and the responsiveness of the crop. On soils marginal to deficient in potassium, crop removal (Table 1) should also be taken into account when planning an ongoing potassium fertilization program.

Table 3. Soil test potassium benchmarks, and corresponding recommended rate of application (lb/ac of K_2O)

Soil Test K (lb/ac in 0-6 in. depth)		Wheat, oats, barley	Canola mustard	Legumes	Potatoes
0 - 50		75	60	80	100
51 - 100	very deficient	60	45	60	80
101 - 150		45	30	40	60
151 - 200	moderately deficient	30*	15*	20	50
201 - 250		15	10	0	40
250 - 300	marginal	0	0	0	30
301+	adequate	0	0	0	0

* Rates above 30 lb/ac for cereals and 15 lb/ac for small seeded crops should be banded or broadcast to avoid seedling injury. At low rates of application, placement with the seed is more effective than banding, and banding is more effective than broadcast (See *Methods of Application*)

The majority of potassium deficient soils in Alberta are only moderately deficient. Maximum response to potassium on these soils is usually obtained with an application of 15 to 30 lb/ac of K_2O to cereal crops. On soils that are very deficient in potassium (soil-test potassium less than 150 lb/ac), high rates of potassium fertilization are usually required to achieve maximum productivity. On very potassium-deficient soils, soil potassium can be "built-up" with an initial application of 200-300 lb/ac of K_2O (broadcast and incorporated), followed in subsequent years with annual applications of about 30 lb/ac. Similar results could be achieved by banding 50 to 60 lb/ac for a few years.

Recent research in Alberta indicates that soil tests do not adequately reflect residual fertilizer potassium where high rates have been applied to very potassium-deficient soils. Following the application of up to 810 lb/ac of K_2O on very potassium-deficient soils, soil test potassium was still in the deficient range, but subsequent crops showed little or no response to additional potassium fertilizer. These heavily fertilized soils contained residual, crop-available potassium that was not reflected in the soil test. Therefore, when high rates of potassium fertilizer are applied to very potassium-deficient soils, the subsequent need for additional fertilizer should be determined on the basis of crop response, rather than solely on the basis of a soil test.

Potassium fertilizers

The most common form of potassium fertilizer used in Alberta is potassium chloride (KCl), which has the analysis 0-0-60 or 0-0-62 (Table 4). It is mined and refined in Saskatchewan. Potassium chloride can be blended with nitrogen and phosphate fertilizers to produce grades such as 10-30-10, 6-24-24, etc.

Table 4. Potassium fertilizers

	Nutrients - % by weight				
Name	N	P_2O_5	K_2O	S	Remarks
Potassium chloride	0	0	60	0	Most commonly available K fertilizer and usually cheapest
	0	0	62	0	
Potassium sulphate	0	0	50	18	Contains sulfur as well as potassium
Potassium nitrate	13	0	37	0	Used mainly for vegetables and fruit trees
Sul-Po-MagTM	0	0	23	16	Specialty fertilizer, containing magnesium

Although not extensively utilized to date, potassium sulphate (K_2SO_4) will soon be produced in Saskatchewan and could be an important fertilizer source in areas where both potassium and sulfur are required nutrients. In the past, potassium sulphate produced in the USA has not been competitively priced with potassium chloride from Saskatchewan.

Method of potassium fertilizer application

Annual Crops

Since potassium uptake depends primarily on root interception, placement of potassium fertilizers with or near the seed is usually the most effective method of application provided the rate of application is not greater than the seed can tolerate. If too much potassium or other fertilizer is placed with the seed, germination and emergence may be delayed or reduced.

The safe level of potassium that can be applied with the seed depends on the crop. In general, smaller seeded crops such as canola have a lower tolerance than cereal grains. The clay and organic matter content of the soil and the soil moisture content will also have an effect on possible germination problems.

With average soil moisture conditions and for medium textures, the total amount of seed placed fertilizer materials should not exceed 175 lb/ac, and the amount of N plus K_2O should not exceed 40 lb/ac. For less tolerant crops such as canola, flax and peas, the application of potassium with the seed should not exceed 15 lb K_2O/ac, provided other fertilizers are not seed placed. These recommendations are based on the use of a double-disc or similar drill, which places the seed and fertilizer in a very

narrow band. If the opener spreads the seed over a wider band, higher rates of fertilizer can be safely placed with the seed.

Side-band placement is an efficient means of applying potassium. In this placement, the fertilizer is in a band approximately 2.5 cm (1 inch) to the side and 2.5 cm (1 inch) beneath the seed. This separation of fertilizer and seed reduces the possible detrimental effects on germination when high rates are applied. Machinery for placing seed and fertilizer in this configuration is not readily available commercially, and the method is not widely practised.

Banding (also referred as deep-banding of potassium into the soil prior to seeding has, to date, not received a great deal of research attention, but there is no reason to believe that this should not be a good method of applying potassium fertilizer.

The two methods, banding prior to seeding and side-banding, should give similar results.

Broadcasting potassium before seeding is less efficient than applying potassium in a band with or near the seed. The major role for broadcast applications of potassium fertilizer will be in "building up" soils extremely deficient in potassium.

Perennial crops

For perennial forage crops, potassium is best applied by broadcasting and incorporating before seeding. This approach will overcome the problem of limited movement of potassium into the soil when applications are made after stand establishment.

Where established stands require potassium fertilizer, then broadcast applications are the only option, and relatively high rates may be required on severely potassium-deficient soils. Fall or spring applications could be made, but fall applications would likely be preferred in dry areas because of the additional moisture available to leach the potassium to the root zone. For potassium deficient soils, potassium fertilizer will reduce alfalfa winter-kill and help maintain the proportion of alfalfa in mixed stands.

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