Potassium Nutrition in Potato Production and its Influence on Quality and Yield

FACT SHEET

Potatoes are a hungry crop removing large amounts of nutrients in both the vines and the tubers produced, and as in every crop the demand for nutrients will vary by variety. (see table 1)

Nutrient Uptake by Potato (table 1)

	N	P	K	Ca	Mg	S
	Pounds of nutrient taken up per 100 cwt					
Vines	**20-30**	**7-11**	**20-25**	**12-14**	**4-6**	**3-3.5**
Tubers	**30-40**	**15-17**	**45-50**	**1.5-2**	**2.5-3**	**1.5-2**
Total	**50-70**	**22-28**	**65-75**	**13.5-16**	**6.5-9**	**4.5-5.5**

variation in nutrient uptake due to varietal differences

In Potato production worldwide producers are torn between yield and quality often times giving up profit per acre for quality concerns. Reducing a nutrient application to the potato crop to increase quality is not the answer. Proper balance of nutrition monitoring the crops demands throughout the season with petiole analysis and providing what the crop needs in a timely manner is the better approach.

Too often a producer will feed excess in nitrogen without a clear understanding of varietal requirements, soil availability and variability and seasonal fluctuations. When we apply Nitrogen to a crop and mange it properly approximately 75% of what we apply will get into the crop that year which is why we see such a response to applied N. As for P and K and most of the other nutrients we apply only about 15-20% of what is applied that year will get into the crop that season the rest of the crops needs come from soil reserves. Building and maintaining good soil nutrient levels is important to finish the crop.

Therefore a good understanding of soil availability and proper placement of these nutrients is important to increase availability. Soil testing a field selecting for field variability is the first step in understanding the potential availability of nutrients in the field that will be available to the potato crop.

In Potato production there is a popular misconception of the role of potassium in potato nutrition and often a producer will be advised to reduce potassium inputs to increase quality (specific gravity). In actual fact what happens is that yield is reduced and in many cases quality is effected. Reducing potassium inputs to maintain better specific gravity is not the answer to the problem. In a well-balanced fertility program potassium application can actually enhance specific gravity.

The exact function of Potassium in plant growth in not clearly understood. We do know however that Potassium is associated with the movement of water, nutrients, and carbohydrates in plant tissue. If adequate potassium is not supplied to the crop, growth is stunted

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and yields and quality will be reduced. Research from around the globe has showed that potassium;

- **Stimulates early growth**
- **Increases protein production**
- **Improves the efficiency of water use**
- **Is vital for stand persistence, winter hardiness and longevity of crops such a alfalfa**
- **Improves resistance to disease and insects**
- **Improves processing quality of a number of crops.**

Potassium Nutrition for Yield and Quality in Potato Production

Potassium is the nutrient that improves the transfer of radiation energy (sunlight) into primary chemical energy in the form of ATP and NADPH. This energy transfer is the fundamental process in plants to convert sunlight energy into carbohydrates, proteins and lipids (MENGEL 1997). Therefore crop quality is not satisfactory if Potassium nutrition is inadequate.

Potassium is also the counter ion to NO_3^- in plant nutrition. In order for the plant to translocate NO_3^- from the root to aerial portions of the plant for conversion to protein and amino acids it requires potassium. Lack of Potassium restricts the NO_3^- transport which leads to nitrate reduction in the roots and an accumulation of amino acids which further restricts the NO_3^- uptake. In Potassium deficient plants nitrate can accumulate in a plant not being incorporate into protein and carbohydrate production hence nitrates accumulate and sugar production is low. An example of this is late season accumulation of nitrates and plants remaining lush and not bulking.

Table 2

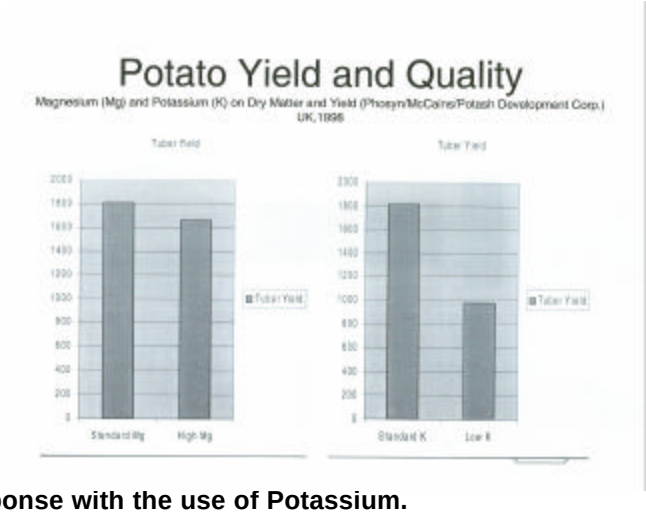


Table 3 shows yield response with the use of Potassium.

Potassium and Yield

K rate	Total	Pay wt.	>10 oz.	S.G.
Lbs/ac		Cwt/ac pounds		
0	216	177	---	1.084
200	254	235	10.8	1.081
300	310	288	11.8	1.085
500	336	319	14.2	1.081

P.E.I. MEY Grower Group field trial Potassium Research

Yield variation will occur according to growing conditions of different years, but ensuring adequate potassium supply to the potato crop can minimize the depression of yields in “poor” years.

Of interest here in **table 3** is the 500 pounds per acre rate where the use of 500 pounds per acre of potassium as KCl gave an increase in yield but had a slight effect on the specific gravity. This is not because of the potassium but due to the impact high levels of potassium has on Mg levels in the plant. Using high concentrations of potassium (high K in planter mix or high broadcast applications of available potassium) without taking into account Mg interaction will impact specific gravity in potato.

Research from a Dutch Survey out of the Netherlands in 1988 clearly shows the relationship to tuber Mg levels and specific gravity in the tuber. (Table 4 and 5).

Table 4

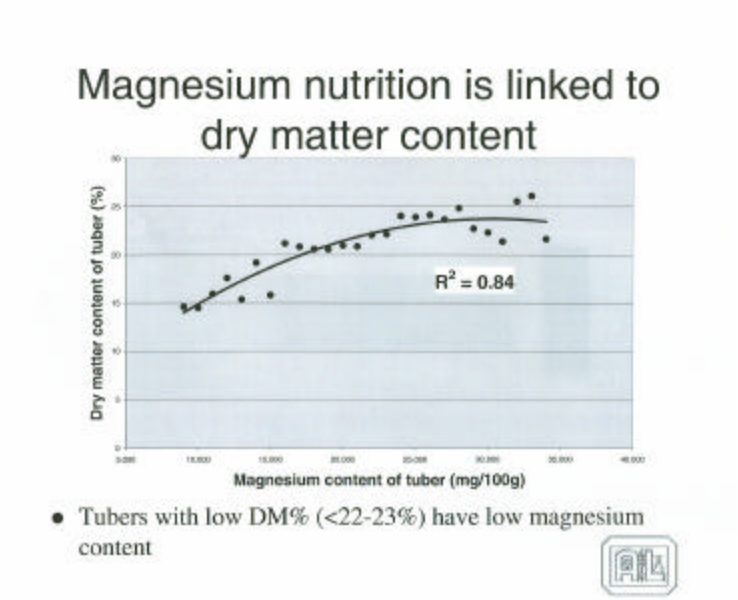
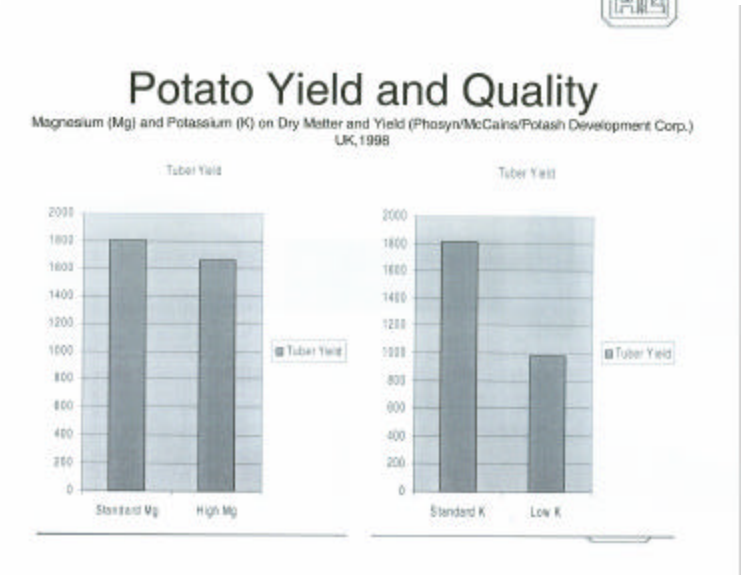


Table 5



These results indicate and support our own research findings that specific gravity influences from potassium application is more directly due to the competition effect between potassium and magnesium in the plant. The higher the Mg in the tuber the higher the dry matter or specific gravity. When we balance Mg with Potassium in the fertility program we can maintain profitable yields without adversely affecting specific gravity.

Potassium and Potato Quality

Potassium however has an even bigger influence on potatoes for a number of potato disorders often occurring in potato production.

Potassium Related Disorders in Potato Production

Blackspot bruise
Shatter bruise
Brown Centre
Hollow Heart
Fusarium
Dark Chipping due to high reducing sugars
Tuber cracking

There is good evidence in research that crops deficient in potassium are less likely to handle stresses caused by drought, water logging, heat, wind and frost, etc.

We see a substantial increase in all these disorders when potassium nutrition is less than ideal throughout the season, but more importantly are the issues with processing potatoes that may go undetected until processed.

Elevated reducing sugars which effect chipping colour are a direct function of low potassium in the tuber **(dia. 1).** When low potassium levels in petioles early in the season are left and no correction taken place, reducing sugars will remain high at harvest. It is important to get potassium levels high early in the season to be able to maintain adequate potassium levels through to harvest.

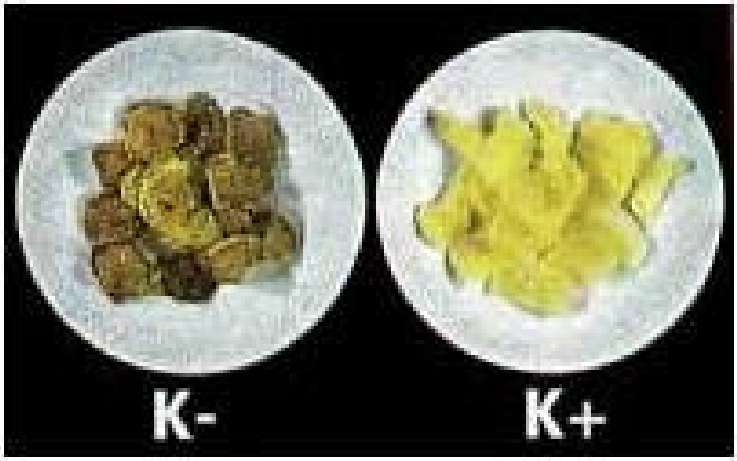


Photo courtesy of The Potash Development Association

Potatoes cooking black or disintegrating on boiling is an indication of low citric acid content of the potato, which again is directly correlated to potassium levels.

Another serous problem that we see related to K:Mg relationship is internal blackening and blackspot occurring in storage which can create complete breakdown of the tuber in storage. This is aggravated when dry matter (specific gravity) is high and is alleviated with higher rates of potash. In this case Muriate of potash is more effective in reducing the occurrence of this problem then sulphate but adequate potassium is the more important factor.

dia. 2

Photo courtesy of The Potash Development Association

The following chart outlines the effect of increasing potassium in tubers.

Type of Change	Effect of Increasing K+	Responsible mechanism
Water Content	**Increase**	**Osmoregulation**
Reducing Sugars	**Decrease**	**Osmoregulation**
Citric Acid	**Increase**	**Cation-anion Balance**
Starch	**Decrease**	**?**
Black spot disorder	**Decrease**	**Lower polyphenol oxidase activity**
Darkening of press sap	**Decrease**	**High citric acid/low polyphenol oxidase**
Discoloration after cooking	**Decrease**	**High citric acid/low chlorogenic acid**
Storage Loss	**Decrease**	**Lower respiration and fungal disease.**

Marschener second edition

In summary reducing the use of Potassium in Potato production to increase specific gravity is not addressing the real problem. Paying attention to total nutrition balance N:K and K:Mg ratios as well as all the other nutrients, will reduce the quality issues while pushing the crop to higher more profitable returns.