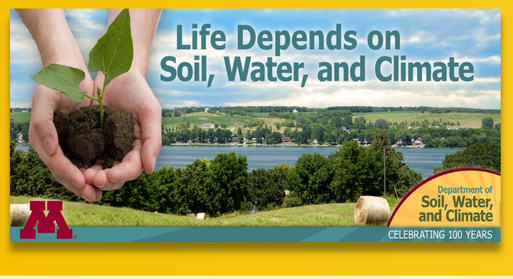

Changes in Soil Chemical Properties Following Application of Polyhalite to Potato

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Background

Polyhalite is a natural marine sedimentary mineral consisting of K, Ca, and Mg hydrated sulfate with an approximate fertilizer value of 0-0-11.7(K)-19(S)-3.6(Mg)-12.1(Ca). Large deposits of polyhalite exist worldwide, generating interest in its potential as a nutrient source for agriculture. Because of its low K:S ratio, high amounts of S would be applied when the product is used to meet crop K demands. Polyhalite is most likely to be useful as a K source on low-organic-matter, acidic, sandy soils with low basic cation content and on crops with a high demand for S. Potatoes are such a crop, frequently grown in such soils.

Objective

The overall objective of this study was to determine the effects of polyhalite on potato yield and residual soil test K, S, Ca, Mg, and pH.

Methods

- 2-year study (now in 3rd year)
- Russet Burbank potatoes grown in acidic, low-organic-matter (1.4%) Hubbard loamy sand soil.
- Six treatments:
  1. Control with 0 K, S, Mg, or Ca added
  2. 373 kg·ha^{-1} K, 608 kg·ha^{-1} SO_4-S,114 kg·ha^{-1} Mg, and 386 kg·ha^{-1} Ca as polyhalite (Sirius Minerals, PLC)
  3. 373 kg·ha^{-1} K as KCl (muriate of potash – MOP)
  4. 373 kg·ha^{-1} K as MOP plus gypsum (2014) or pelletized lime (2015) and Epsom salts as S, Mg, and Ca sources
  5. 280 kg·ha^{-1} K as polyhalite and 93 kg·ha^{-1} K as MOP
  6. 187 kg·ha^{-1} K as MOP and 187 kg·ha^{-1} K as polyhalite

Measurements

- Marketable yield (tubers above 85 g)
- Soil test* K, Ca, Mg, SO_4-S, and pH before treatment application and at harvest.

*NH_4OAc K, Ca, Mg; CaP SO_4-S; 1 soil:1 water pH.

Table 1. Application rates of elements in fertilizer treatments.

Treatment number	K source	Other amendments	Nutrients applied (kg·ha^{-1})			
			K	Mg	Ca	SO_4-S
1	-	None	0	0	0	0
2	Polyhalite	None	373	114	386	608
3	MOP	None	373	0	0	0
4 (2014)	MOP	Gypsum & $MgSO_4$	373	114	211	322
4 (2015)	MOP	Lime & $MgSO_4$	373	114	386	153
4 (2016)	MOP	Gypsum & $MgSO_4$	373	114	386	460
5	3 polyhalite : 1 MOP	None	373	85	289	456
6	1 polyhalite : 1 MOP	None	373	57	193	304

Table 2. Deposition rates of elements in irrigation water and rainfall in 2014 and 2015.

Year	Nutrients deposited in rainfall and irrigation water (kg·ha^{-1})			
	K	Mg	Ca	S
2014	2	58	154	16
2015	2	49	129	13

Results

Table 3. Marketable yields (± S.D.) of Russet Burbank potatoes in response to treatment in 2014, 2015, and 2016*.

Treatment	Marketable yield (Mg·ha^{-1})			
	2014	2015	2016	All years
Control	46.5 c	49.1 b	36.7 b	44.1 c
Polyhalite	52.5 b	53.7 ab	53.5 a	52.8 ab
MOP	47.5 c	50.4 ab	48.9 a	49.0 b
MOP + amendments	54.0 ab	48.2 b	51.6 a	51.3 ab
3:1 polyhalite:MOP	52.6 b	56.9 a	51.7 a	53.7 a
1:1 polyhalite:MOP	56.6 a	53.3 ab	51.7 a	53.9 a

*Treatment x Year interaction was NS.
Within a column, means followed by the same letter are not significantly different at P=0.1.

Table 4. Change in soil test K in response to treatment in 2014 and 2015.

Treatment	Soil test K (mg·kg^{-1})					
	2014			2015		
	Initial	Final	Change	Initial	Final	Change
Control	97 a	57 d	-41 b	80 a	60 c	-20 c
Polyhalite	102 a	93 bc	-9 a	82 a	106 ab	24 a
MOP	106 a	108 ab	2 a	93 a	124 a	31 a
MOP + amendments	111 a	115 a	4 a	82 a	115 a	34 a
3:1 polyhalite:MOP	94 a	83 c	-11 a	91 a	95 b	4 b
1:1 polyhalite:MOP	93 a	84 c	-9 a	75 a	108 ab	33 a

Within a column, means followed by the same letter are not significantly different at P=0.1.

Results, cont.

Table 5. Change in soil test Mg in response to treatment in 2014 and 2015.

Treatment	Soil test Mg (mg·kg^{-1})					
	2014			2015		
	Initial	Final	Change	Initial	Final	Change
Control	51 a	62 a	12 bc	54 a	68 b	14 c
Polyhalite	51 a	73 a	22 ab	40 a	65 b	24 ab
MOP	43 a	47 b	4 c	43 a	55 c	12 c
MOP + amendments	44 a	74 a	30 a	50 a	80 a	30 a
3:1 polyhalite:MOP	49 a	66 a	17 b	44 a	62 bc	18 bc
1:1 polyhalite:MOP	50 a	66 a	16 b	48 a	65 b	17 bc

Within a column, means followed by the same letter are not significantly different at P=0.1

Table 6. Change in soil test Ca in response to treatment in 2014 and 2015.

Treatment	Soil test Ca (mg·kg^{-1})					
	2014			2015		
	Initial	Final	Change	Initial	Final	Change
Control	357 a	364 ab	7 ab	306 a	351 a	45 c
Polyhalite	345 a	406 a	61 a	235 c	356 a	121 a
MOP	310 a	276 b	-33 b	249 abc	282 a	33 c
MOP + amendments	301 a	334 ab	33 ab	293 ab	336 a	43 c
3:1 polyhalite:MOP	344 a	415 a	72 a	239 bc	345 a	106 ab
1:1 polyhalite:MOP	322 a	335 ab	13 ab	275 abc	335 a	61 bc

Within a column, means followed by the same letter are not significantly different at P=0.1.

Table 7. Change in soil test SO_4-S in response to treatment in 2014 and 2015.

Treatment	Soil test SO_4-S (mg·kg^{-1})					
	2014			2015		
	Initial	Final	Change	Initial	Final	Change
Control	3 a	4 c	1 b	4 a	6 e	2 e
Polyhalite	3 a	69 a	66 a	3 a	45 a	42 a
MOP	3 a	4 c	2 b	4 a	6 e	2 e
MOP + amendments	3 a	61 a	58 a	4 a	15 d	11 d
3:1 polyhalite:MOP	3 a	44 ab	41 ab	3 a	30 b	26 b
1:1 polyhalite:MOP	3 a	22 bc	19 b	4 a	21 c	17 c

Within a column, means followed by the same letter are not significantly different at P=0.1.

Table 8. Change in soil test pH in response to treatment in 2014 and 2015.

Treatment	Soil test pH (mg·kg^{-1})					
	2014			2015		
	Initial	Final	Change	Initial	Final	Change
Control	5.2 a	4.9 a	-0.4 a	5.0 a	4.7 b	-0.3 a
Polyhalite	5.2 a	4.8 a	-0.4 a	4.9 a	4.7 b	-0.2 a
MOP	5.2 a	4.7 a	-0.5 a	4.9 a	4.7 b	-0.2 a
MOP + amendments	5.2 a	4.8 a	-0.5 a	5.0 a	5.0 a	0.0 a
3:1 polyhalite:MOP	5.2 a	4.8 a	-0.5 a	4.9 a	4.6 b	-0.3 a
1:1 polyhalite:MOP	5.3 a	4.9 a	-0.4 a	5.0 a	4.7 b	-0.3 a

Within a column, means followed by the same letter are not significantly different at P=0.1.

Summary and Conclusions

- Loading of Ca and Mg with irrigation and rainfall inputs exceeded the fertilizer recommendations for Ca and Mg.
- Loading of S with irrigation and rainfall provided over 1/3 of the fertilizer recommendation for S.
- Marketable yields were as high or higher with polyhalite as the K source than with MOP or the zero-K control.
- Blends of polyhalite and MOP were as effective as pure polyhalite as K sources.
- Without K fertilization, soil K decreased significantly over the season relative to treatments receiving K. Source of K did not affect the change in soil K.
- Soil test Ca and Mg were lowest in the MOP-only treatment (#2), yet increased in all treatments due to inputs from irrigation water.
- Soil test SO_4-S was lowest in the control and MOP-only treatments, with 100% polyhalite having up to 65 mg/kg higher soil SO_4-S than these.
- In 2014, soil pH decreased by 0.4 – 0.5 units in all treatments.
- In 2015, soil pH decreased by 0.2 – 0.3 units in all treatments except the one receiving pelletized lime, which showed no change in pH.
- Polyhalite had no effect on soil pH relative to other amendments tested, with the possible exception of lime.

Future Directions

In 2016, we included treatments intended to identify effects of Mg and lime vs. gypsum applications in this system.

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