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Potato potassium requirement and Polyhalite fertilizer management

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Outline

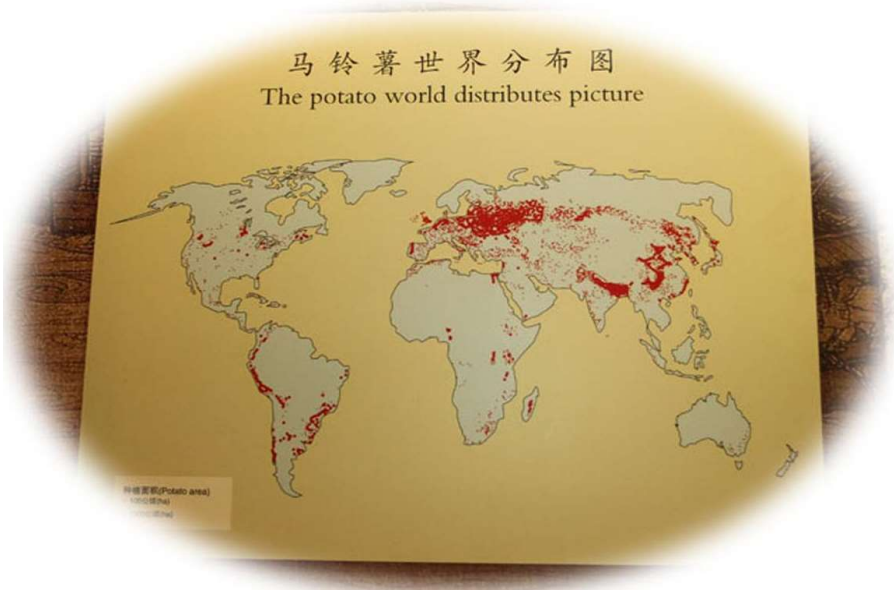
Part 1. potato potassium requirement

Part 2. Polyhalite fertilizer management in potato production

Potato production worldwide

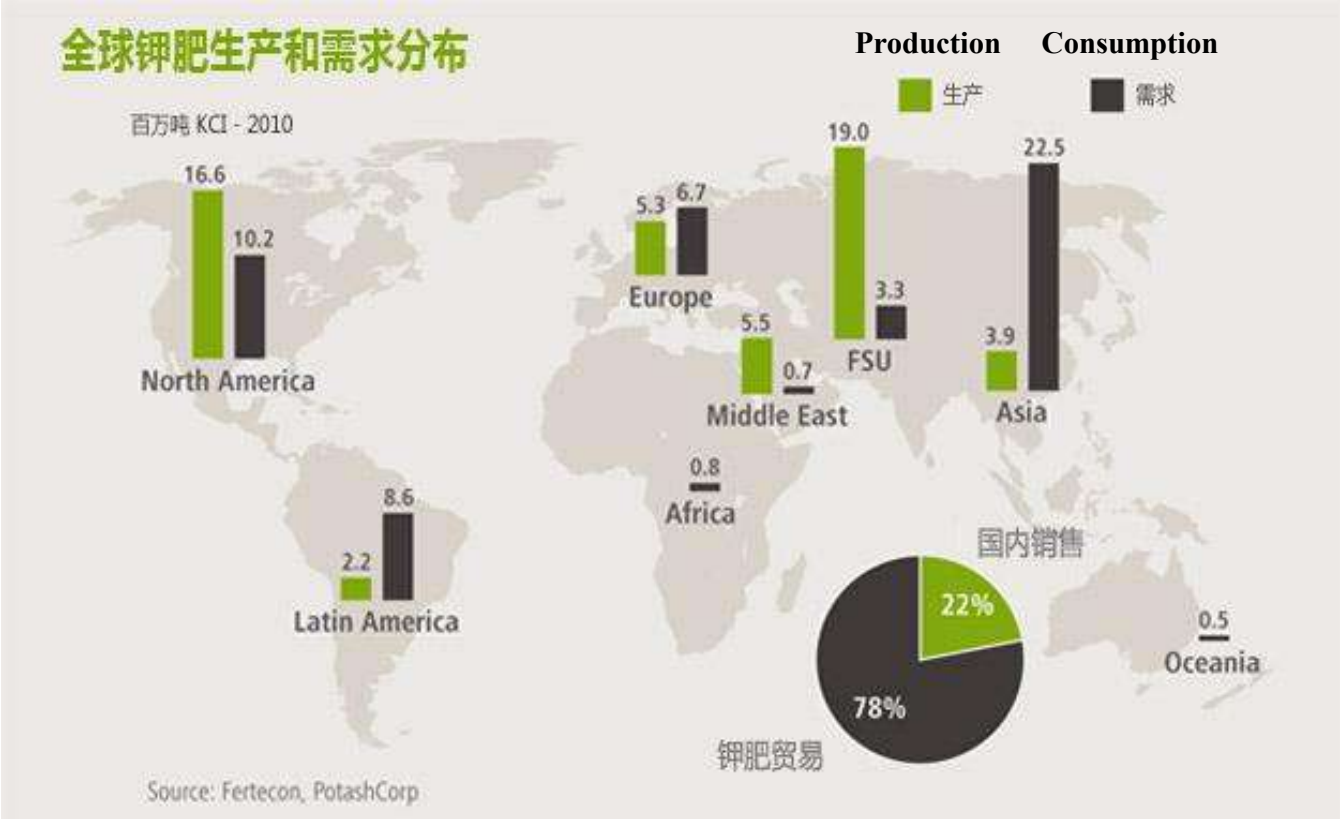
Potato consumption as food (millions tons)			
	2015 consumption	2015-2050 increase ratio	2050 consumption
World	253.4	+30.40%	330.5
Asia	127.2	+17.80%	149.8
Europe	62.6	-4.60%	59.7
Africa	21.9	+105.20%	45
North America	20.9	+23.60%	25.8
South America	12.3	+21.70%	15
Oceania	1.9	+44.50%	2.7

(Data source: FAO)



- **More than 150 countries and regions produce potato among which the planting area of China accounts for 27%, ranking No.1 in the world.**

Potash fertilizer production and consumption



China consumes about 40% potash fertilizer in the world.

China is a Potash fertilizer deficient country, more than 40% potash fertilizer depends on import.

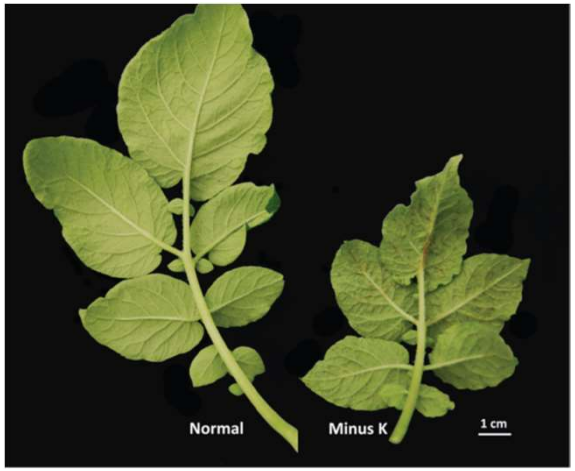
Part 1. Potato potassium requirement

Physiological functions of Potassium(K)

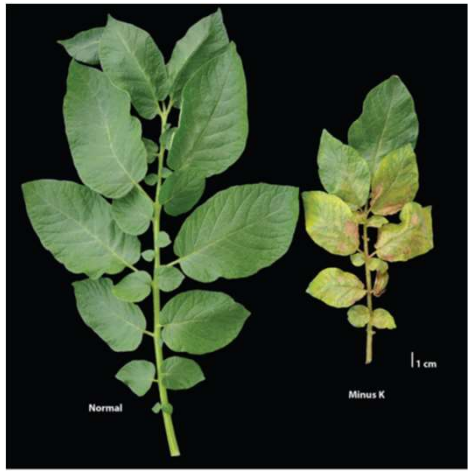
- ***Regulation of carbohydrates synthesis and transporting***
- ***Maintaining proper water relations in plants***
- ***Contributes most to crop quality***

K Deficiency Symptoms in potato

Potassium deficiency is initially observed by stunted plant growth, slightly darker green appearance, and crinkled leaves.



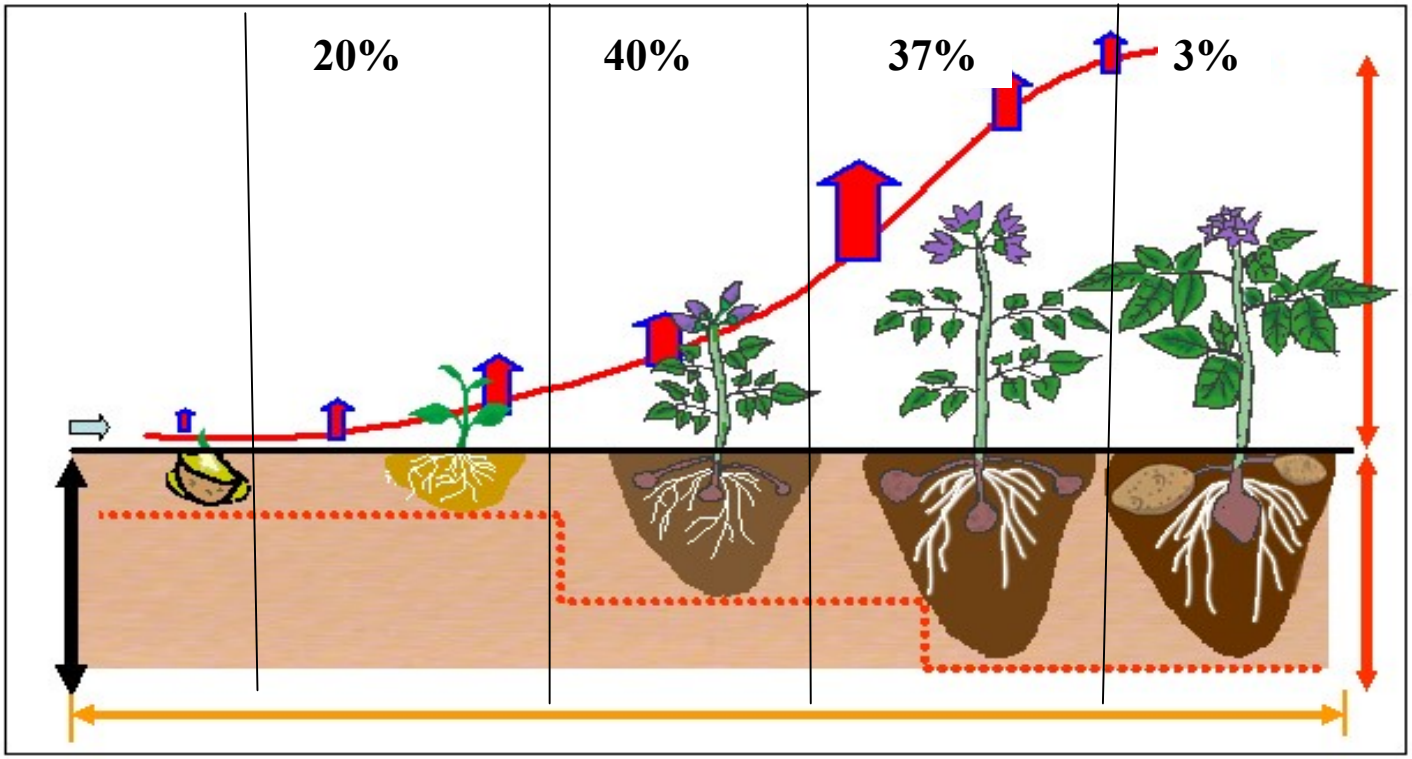
Underside of potassium-deficient potato leaves exhibit stunting, a crinkled appearance, and the start of veinal necrosis.

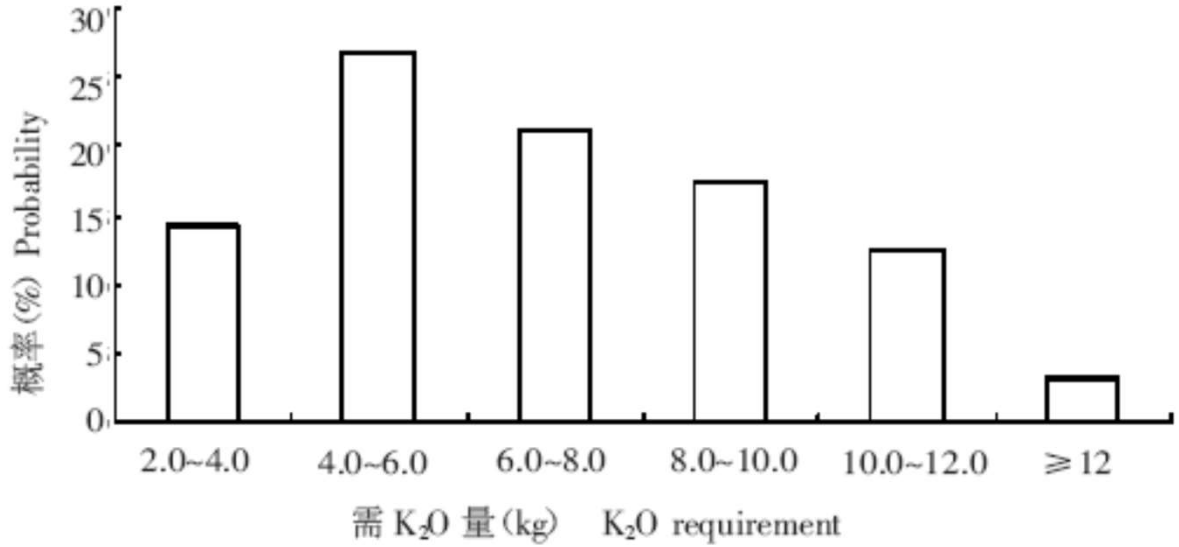


Advanced symptoms of potassium deficiency exhibit signs of severe chlorosis and necrosis.

(**Plant Nutrition Diagnostics:** POTATO., 2018)

Potassium absorption at different developmental stage





Varied dramatically in potassium requirement!

(Gao et al., 2011)

Luxury Absorption of Potassium by Potato Plants

Table. Results of field experiments under rain-fed conditions

Site		CK	K1	K2	K3
Duolong	Applied K (K_2O, kg/ha)	0	37.5	75	112.5
	Tuber yield (kg/ha)	19,167 c	24,446 b	30,281 a	30,557 a
	K uptake (kg/ha)	121 b	124 b	129 b	223 a
	K required to produce 1,000 kg tuber (kg)	6.3	5.1	4.3	7.3
Zhenglanqi	Applied K (K_2O, kg/ha)	0	22.5	45	67.5
	Tuber yield (kg/ha)	14,295 b	16,430 a	16,350 a	15,720 a
	K uptake (kg/ha)	53 b	62 ab	64 ab	72 a
	K required to produce 1,000 kg tuber (kg)	3.7	3.8	3.9	4.6
Wuchuan	Applied K (K_2O, kg/ha)	0	33.8	67.5	101.3
	Tuber yield (kg/ha)	15,302 b	17,910 a	17,954 a	16,976 a
	K uptake (kg/ha)	70 b	87 a	90 a	99 a
	K required to produce 1,000 kg tuber (kg)	4.6	4.8	5	5.8

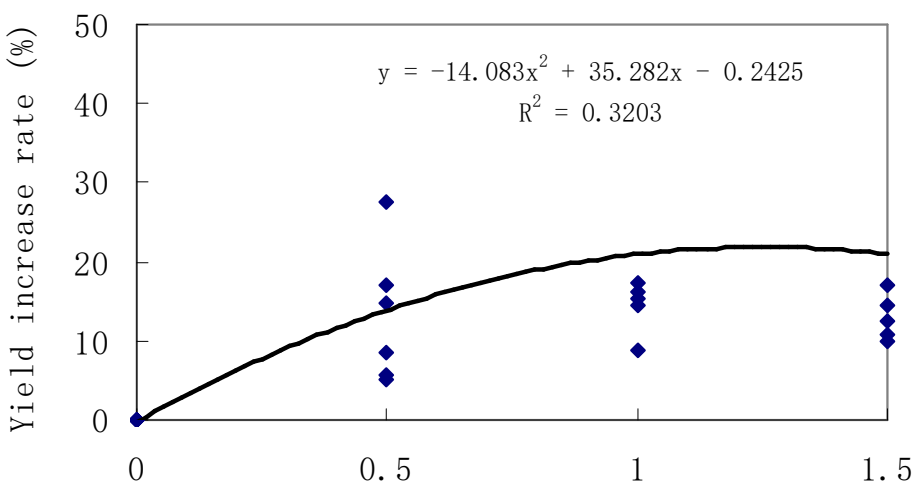
* CK, K1, K2, K3 treatments represent 0, 0.5, 1.0 and 1.5 times the recommended rate of K application

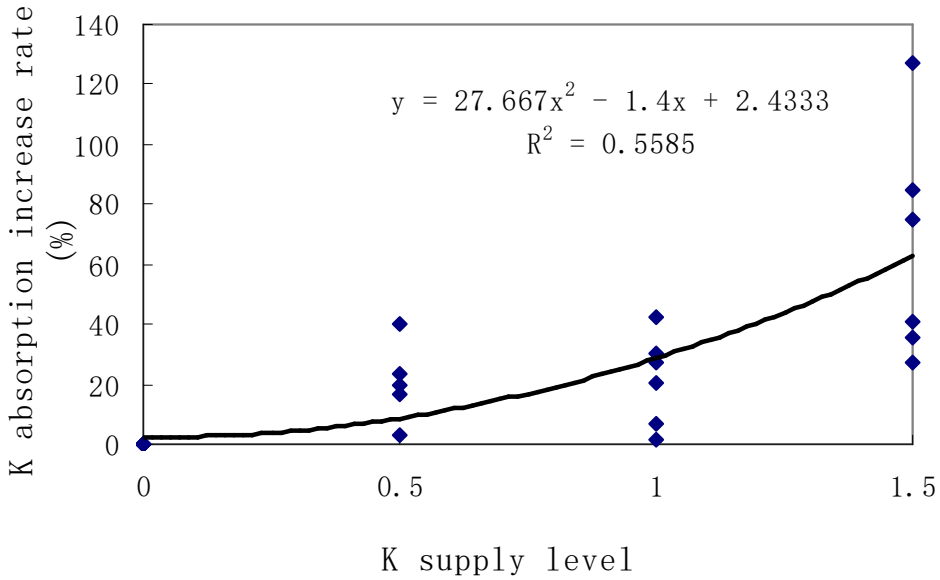
Table. Results of field experiments under irrigated conditions

Site		CK	K1	K2	K3
Taipusi	Applied K (K_2O, kg/ha)	0	67.5	135	202.5
	Tuber yield (kg/ha)	52,013 c	54,675 b	56,610 ab	58,545 a
	K uptake (kg/ha)	169 d	202 c	241 b	383 a
	K required to produce 1,000 kg tuber (kg)	3.3	3.7	4.3	6.6
Chayouhou	Applied K (K_2O, kg/ha)	0	97.5	195	292.5
	Tuber yield (kg/ha)	42,030 c	44,460 b	48,825 a	48,150 a
	K uptake (kg/ha)	329 c	306 d	334 b	419 a
	K required to produce 1,000 kg tuber (kg)	7.8	6.9	6.8	8.7
Chayouzhong	Applied K (K_2O, kg/ha)	0	97.5	195	292.5
	Tuber yield (kg/ha)	35,250 c	38,295 b	40,680 a	41,235 a
	K uptake (kg/ha)	151 c	211 b	196 b	264 a
	K required to produce 1,000 kg tuber (kg)	4.3	5.5	4.8	6.4

* CK, K1, K2, K3 treatments represent 0, 0.5, 1.0 and 1.5 times the recommended rate of K application

Potato yield and K uptake of plants grown with different rates of applied K





*** The horizontal axis indicates 0.5. 1.0 and 1.5 times the recommended rates of K application;**

*** The vertical axis indicates the %increase over the check treatment**

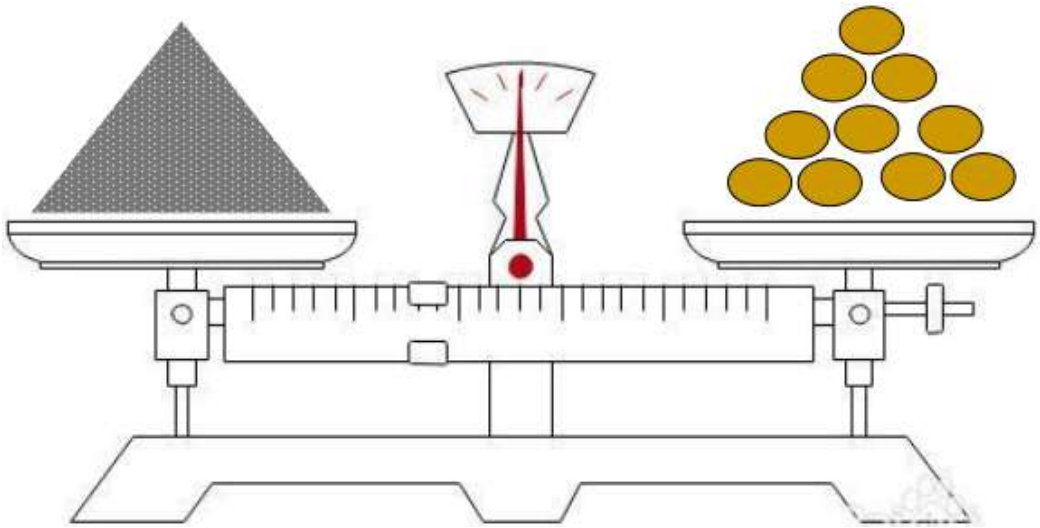
(Am. J. Potato Res. (2014) 91:573–578)

Potassium requirement of potato

N: 5 kg

P_2O_5: 2 kg

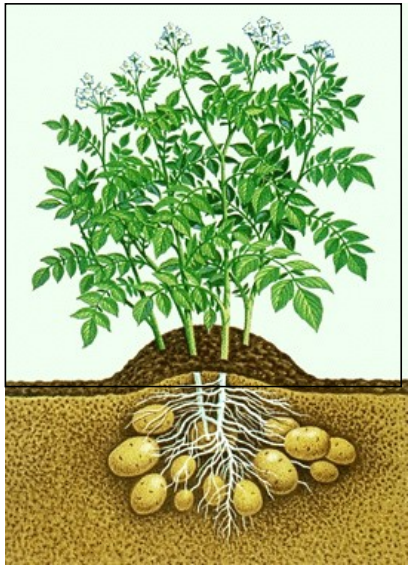
K_2O: 9 kg



1000 kg

fresh tuber

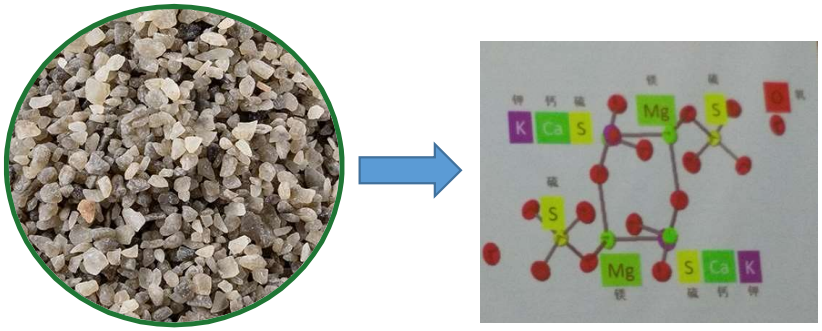
Potato Potassium Status Diagnosis by Ion Meter



In progressing •••

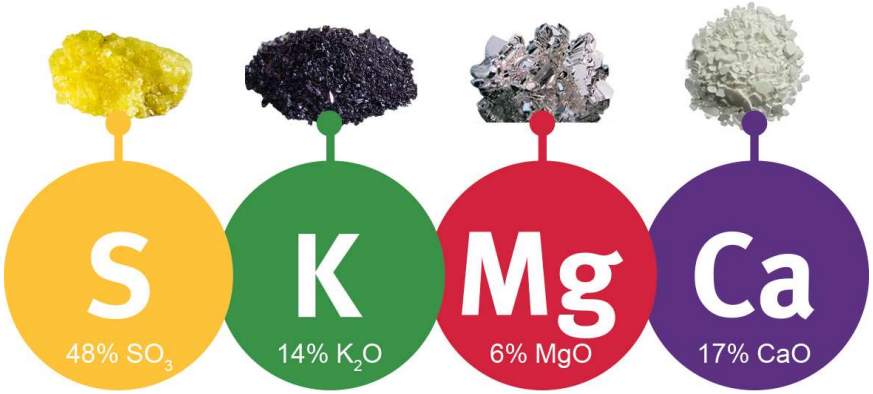
Part 2. Polyhalite fertilizer management in potato production

Polyhalite

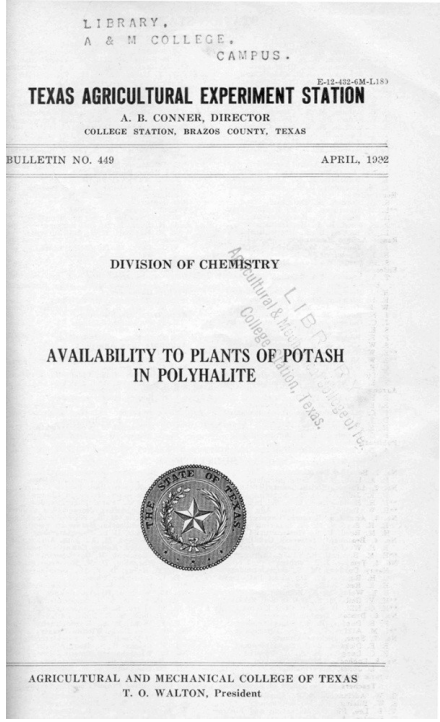


$K_2Ca_2Mg(SO_4)_4 \cdot 2(H_2O)$

The new 4-in-1 fertilizer



College Station, Texas.



This article from April 1932 showcases the benefits for polyhalite to plants.

Experimental Design of Polyhalite effects in potato

Date of experiments:
2017-2018

Density:
42000 plants/ha

Cultivar:
Kexin No.1

Irrigation method:
drip irrigation

Fertilization rates: 300 kg/ha N, 180 kg/ha P_2O_5

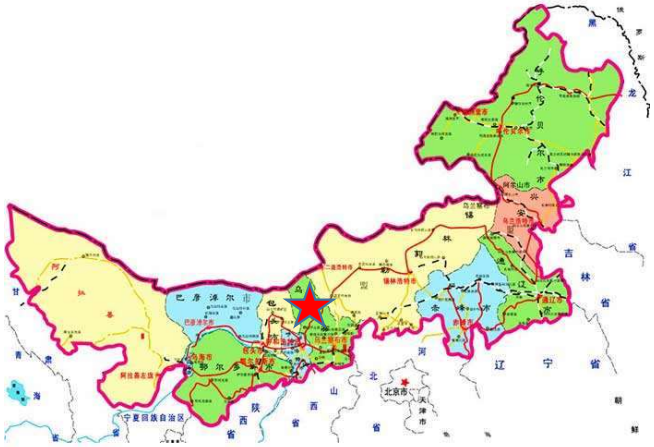


Table. Treatment of of Polyhalite application in potato

Treatments 处理	Basal Dressing (kg ha^{-1})	
	K_2O (as K_2SO_4, potassium sulfate)	Polyhalite
CK	300	
T1	90	1500 (210 K_2O contained)
T2	234	469 (66 K_2O contained)

Experimental site
(内蒙古乌兰察布市察右中旗)

Yield and its components

Year	Treatments	Yield (kg/ha)	Tuber number per seedling	Commercial tuber rate (%)
2017	CK	41835 ab	6.9 ab	84.6 a
	T1	36190 b	5.7 b	84.4 a
	T2	50727 a	7.4 a	83.0 a
2018	CK	38001 b	6.07 b	58.5 a
	T1	48633 a	7.33 a	52.1 a
	T2	47393 a	6.82 a	59.9 a

(Unpublished data)

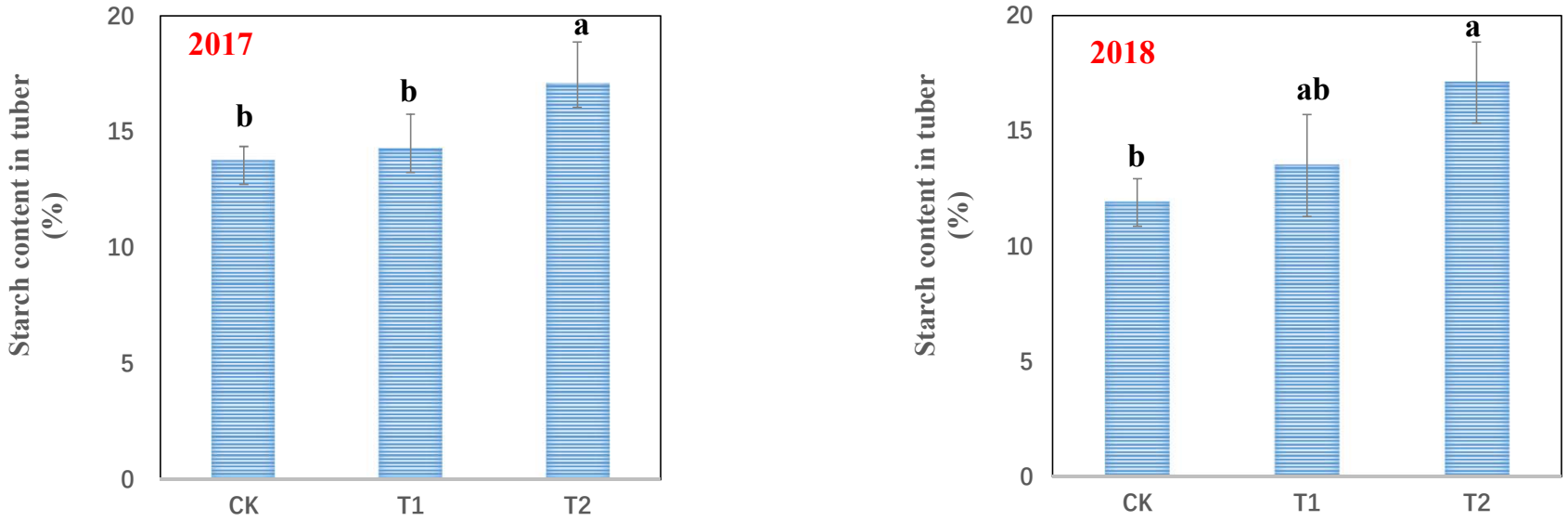
CK

T1

T2

Tuber quality

Starch and reduced sugar



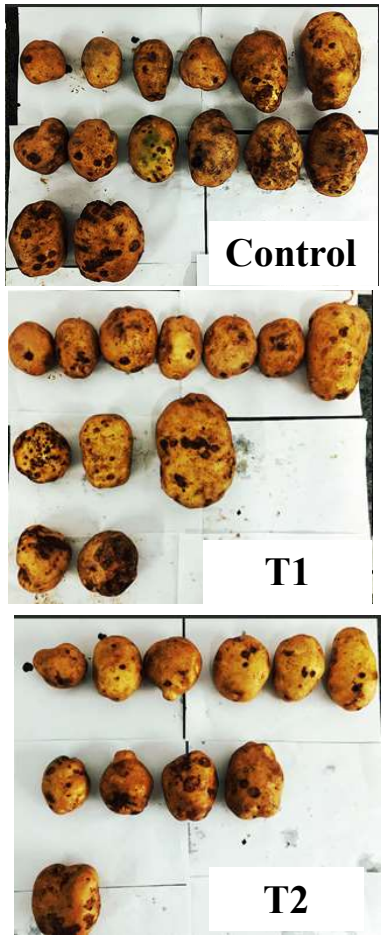
◆ The suitable fertilization combination (1/2 polyhalite + 1/2 K_2SO_4) promotes starch accumulation in potato tuber, but no effect on reduced sugar contents.

Common scab resistance

Table. The incidence of common scab under different treatments

Year	Treatments	Disease incidence (%)	Disease index
2017	CK	53.7	14.5
	T1	54.8	16.4
	T2	21.9	6.7
2018	CK	8.33	5.56
	T1	15	6.11
	T2	1.67	4.44

* 病情指数= ∑ （病级x该病级个数）/最高病级数x总调查数 x100

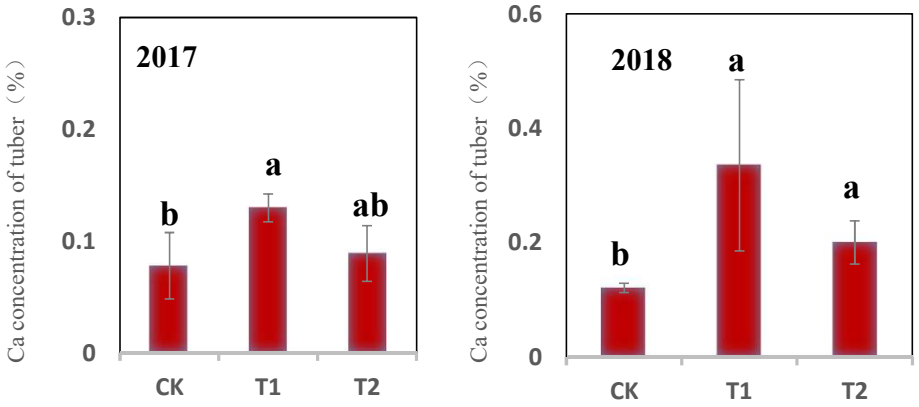


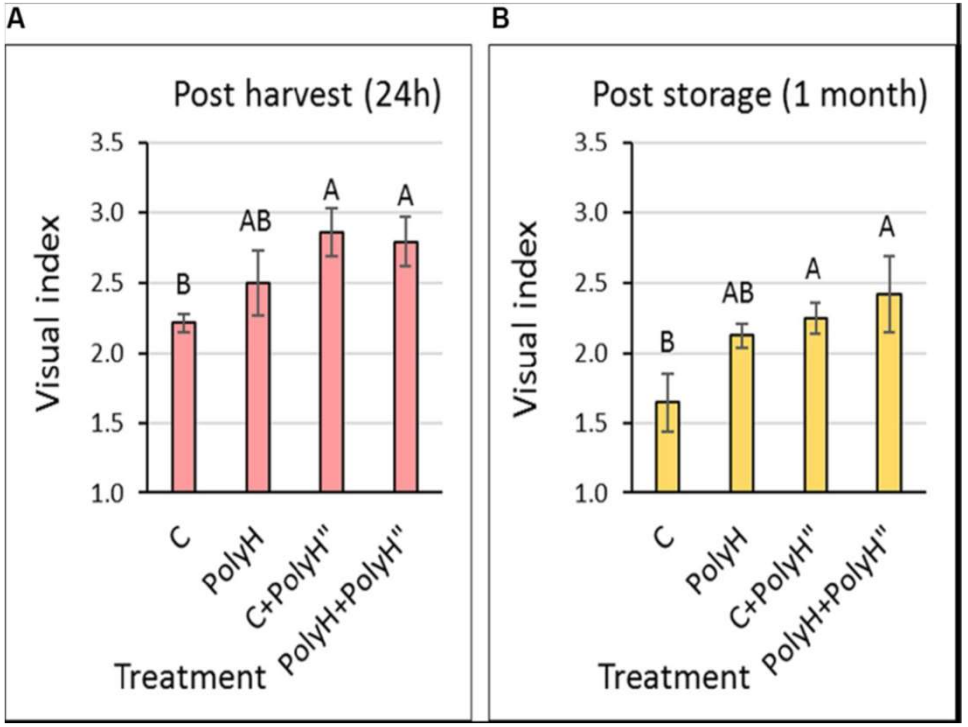
Injury tolerance of tuber skin

Bruise index of tuber skin

	2017	2018
CK	53.3	98.5
T1	65.0	94.2
T2	47.8	81.1

* Harvested tuber shook 3 min at 270/min, then 5 grades were classified according to the degree of tuber skin bruise. Bruise index was calculated referred as Disease index.



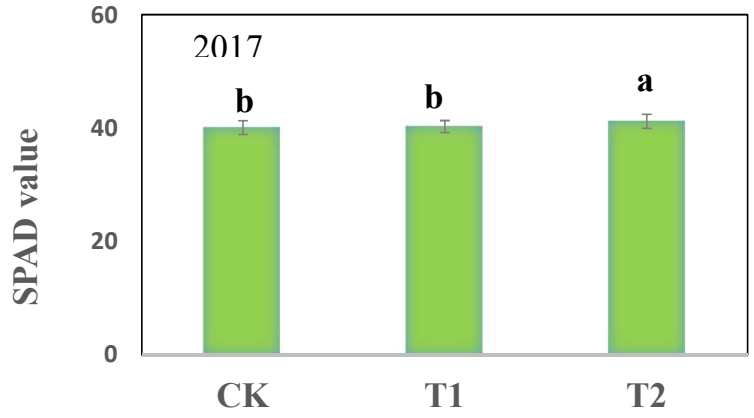


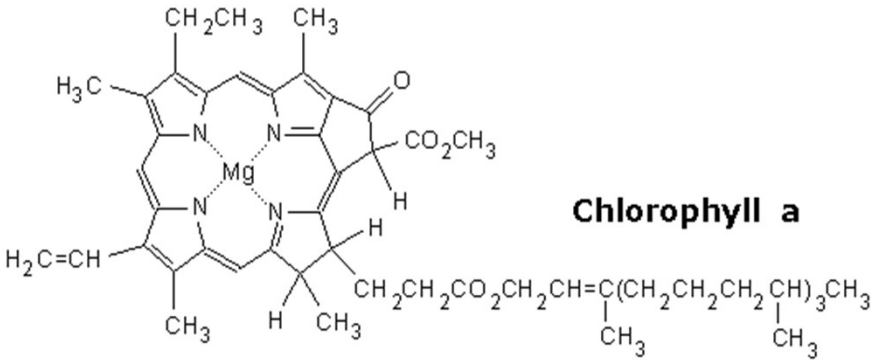
(Alexandra et al., 2019)

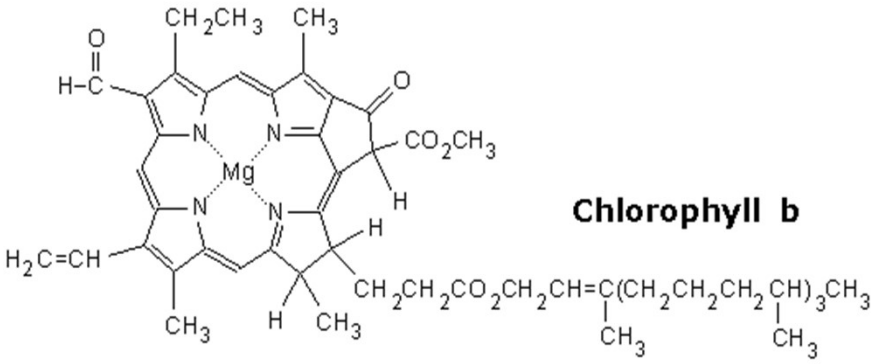
The possible role of Mg on yield promotion

Mg concentration in leaf（mg/g）

Treatment	2017 52 DAE	2018 45 DAE
CK	0.30	0.64
T1	0.31	0.65
T2	0.34	0.70







Leaf area index

Year	Treatment	18 DAE	33 DAE	52 DAE	78 DAE	91 DAE
2017	CK	0.80 ab	1.92 b	2.15 b	2.37 c	2.06 b
	T1	0.72 b	2.15 a	2.72 a	2.57 b	2.04 b
	T2	0.95 a	2.20 a	2.67 a	2.72 a	2.31 a
2018	Treatment	15 DAE	30 DAE	45 DAE	70 DAE	90 DAE
	CK	0.69 b	2.43 b	3.52 b	3.39 a	2.34 a
	T1	1.20 a	2.99 a	4.62 a	3.76 a	2.32 a
	T2	1.14 a	3.22 a	4.13 a	3.46 a	2.92 a

Dry weight of whole plants (g/seedling)

Year	Treatment	18 DAE	33 DAE	52 DAE	78 DAE	91 DAE
2017	CK	16.06	67.53	163.54	279.17	366.93
	T1	13.00	71.03	163.06	311.93	415.35
	T2	19.54	75.08	274.84	313.64	447.99

Year	Treatment	15 DAE	30 DAE	45 DAE	70 DAE	90 DAE
2018	CK	10.1 b	31.8 b	148.0b	177.4 b	189.9 b
	T1	13.2a	42.63 a	205.3 a	262.4 a	278.8 a
	T2	12.5 a	41.3 a	199.8 a	259.3 a	271.9 a

Conclusion

- Potato consumption increase and lack of potash fertilizer force china enhance K use efficiency of potato.

- About 9 kg K_2O is needed for producing 1000 kg fresh tuber in northern China, but luxury absorption of potassium exists in potato plants.

- Polyhalite application could increase potato yield and starch content in tuber, enhance common scab and tuber skin resistance.

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