POLY4 AS A SULPHUR SOURCE FOR FRESH MARKET TOMATO PRODUCTION IN BRAZIL

Simone C. Mello; University of São Paulo
Robert Meakin and Kiran Pavuluri, Sirius Minerals

Presented by Brad Farber
Sirius Minerals

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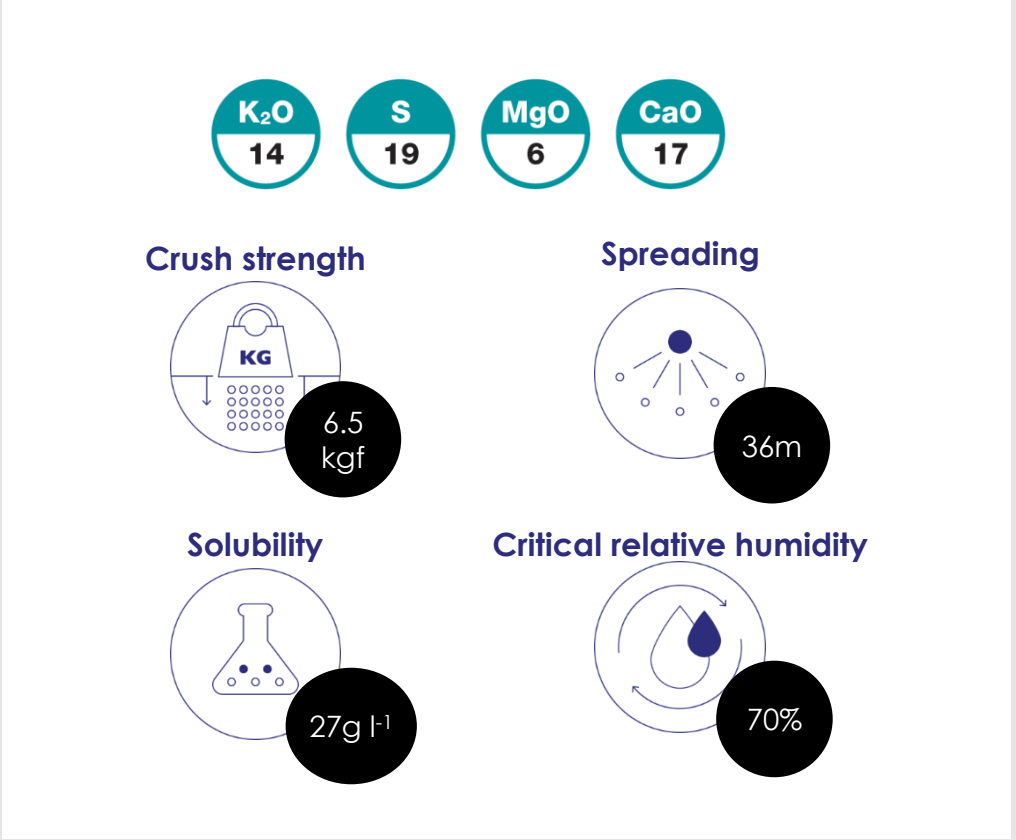
INTRODUCTION TO POLY4 ($K_2SO_4.MgSO_4.2CaSO_4.2H_2O$)

POLY4 is the name for polyhalite product from Sirius Minerals. POLY4 is a multi-nutrient fertilizer that is low in chloride and is certified for organic use.

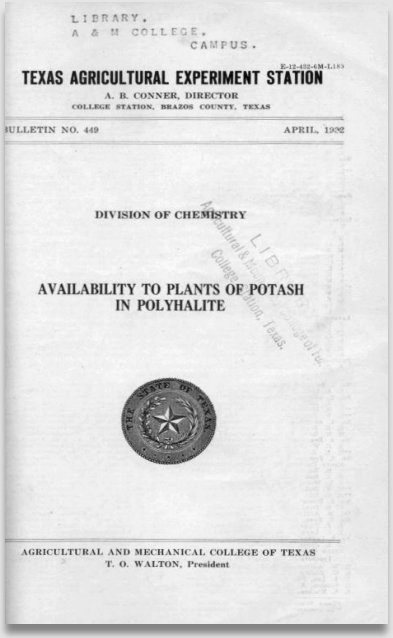
Sirius Minerals Plc is focused on the construction of its polyhalite project in the United Kingdom. The project involves the construction of a new state-of-the-art mine and associated processing and port infrastructure to produce bulk volumes of POLY4.

https://www.youtube.com/embed/0b_Ubd-6EWM?ecver=2



SIGNIFICANCE OF THE STUDY

- Limited literature
- Discovery of huge deposits of MOP in Canada and its commercialisation (muriate of potash)
- Zechestein deposit in North Sea basin containing polyhalite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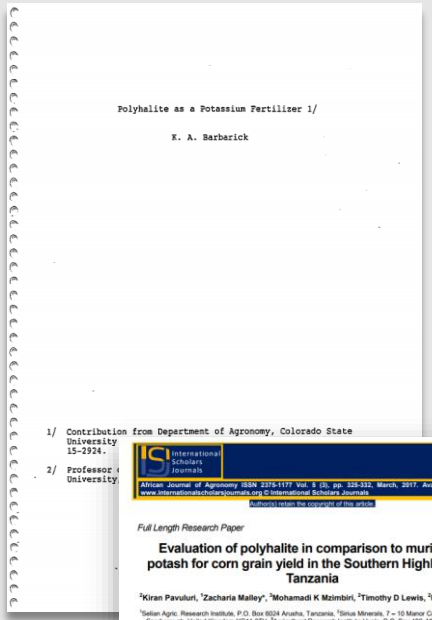
DIVISION OF CHEMISTRY

AVAILABILITY TO PLANTS OF POTASH IN POLYHALITE

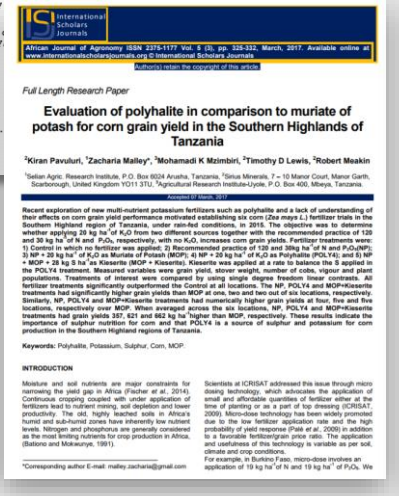
AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS
T. O. WALTON, President


Polyhalite as a Potassium Fertilizer 1/

K. A. Barbarick

1/ Contribution from Department of Agronomy, Colorado State University 15-2924.

2/ Professor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Full Length Research Paper

Evaluation of polyhalite in comparison to muriate of potash for corn grain yield in the Southern Highlands of Tanzania


Potato Response to Polyhalite as a Potassium Source Fertilizer in Brazil: Yield and Quality

Fraps, G. S., and H. Schmidt. 1932. Availability to plants of potash in Polyhalite, Bulletin No. 449, Texas Agricultural Experiment Station, College Station, Texas.

Barbarick, K. A. 1991. Polyhalite application to sorghum-sudangrass and leaching in soil columns. Soil Science 151: 159-166.

Pavuluri K., Z. Malley, M. K. Mzimbiri, T. D. Lewis, and R. Meakin. 2017. Evaluation of polyhalite in comparison to muriate of potash for corn grain yield in the Southern Highlands of Tanzania. African Journal of Agronomy 5: 325-332

Mello, S., F.J. Pierce, R. Tonhati, G.S. Almeida, D.D. Neto, and K. Pavuluri. 2018a. Potato response to polyhalite as a potassium source fertilizer in Brazil: Yield and Quality. Hortscience. 53:373–379.

Mello, S., R.N. Tonhati, D.D. Darapuneni, and K. Pavuluri. 2018b. Response of tomato to polyhalite as a multi nutrient fertilizer in south-east Brazil. J. Plant Nutri. in press).

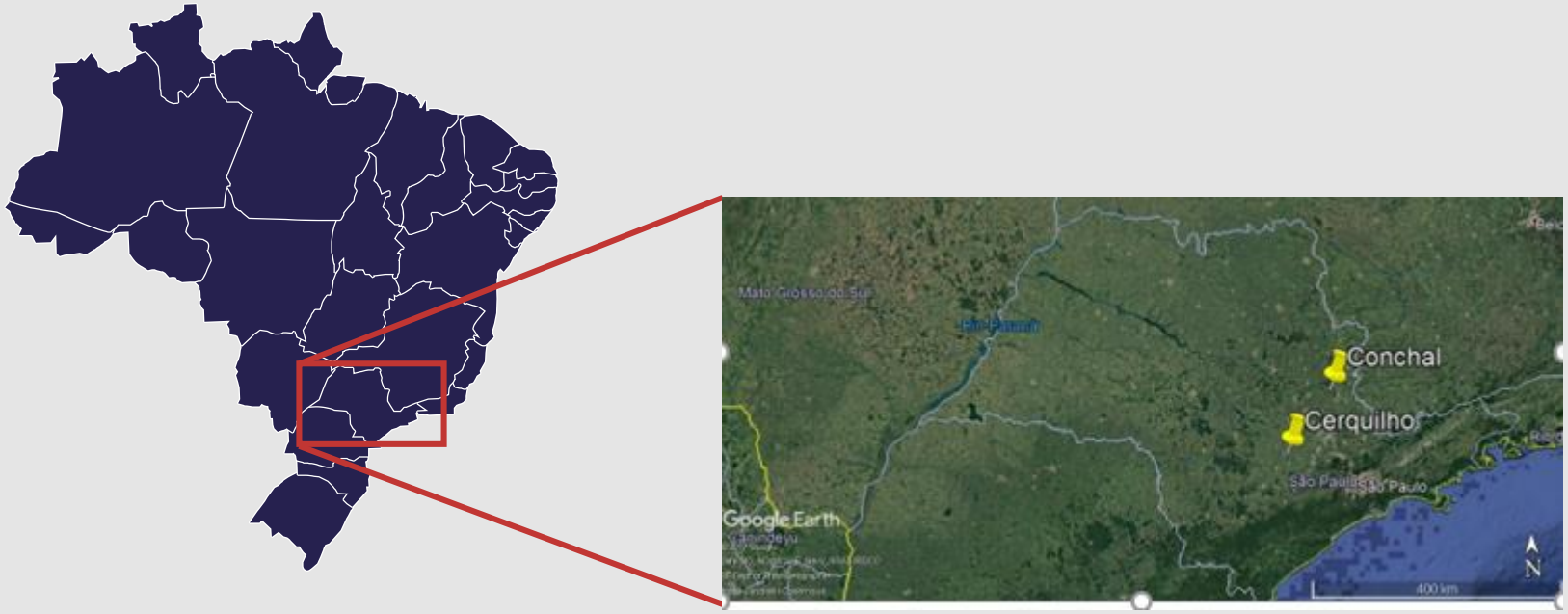
OBJECTIVES

The specific research questions were:

- What is the influence of different S fertilizers on tomato yield and fruit quality?
- How do different S sources affect tomato foliar and fruit nutrient concentrations?
- What is the influence of S source and rate on post-harvest soil nutrient parameters?

MATERIALS AND METHODS

Trial sites: (i) Conchal and (ii) Cerquilho in Sao Paulo State in Brazil



Source: 4000-USP-4024-17

EXPERIMENTAL DESIGN

- Five treatments arranged in randomized complete block design
- Five replications
- Three locations
- Statistical analysis
  - GENSTAT statistical analysis software
  - Alpha = 0.1
  - Fishers LSD at the 10% significance level
  - Locations were treated as fixed factors

Source: 4000-USP-4024-17

TREATMENT STRUCTURE

Nutrient applied per treatment, kg ha^{-1}

Treatment	K_2O		S	CaO	MgO
	Cerquilho	Conchal	All Sites		
Control	0	0	0	0	0
MOP	300	200	0	0	0
POLY4 + MOP	300	200	40	36	13
SOP + MOP	300	200	40	0	0
SOP-M + MOP	300	200	40	0	33
SSP + MOP	300	200	27	40	0

Source: 4000-USP-4024-17

SOIL SAMPLING

- Pre planting -15 soil samples from 0-20 cm depth – prior to tomato planting
- Post-harvest – soil samples from each experimental unit

Soil sampling at experimental sites

Soil fertility status of the trial sites

	Soil test					
	pH	P	K	Ca	Mg	SO_4-S
Locations		mg kg^{-1}				
Cerquilho 1	5.5	10.3	86	254	63	6.6
Cerquilho 2	5.4	9.7	63	202	52	6.4
Conchal	5.0	8.4	82	320	117	7.7

Source: 4000-USP-4024-17

TIME AND METHOD OF FERTILIZER APPLICATION

- Pre-plant –
  - 35% of total K_2O
  - 100% of the P_2O_5
  - 20% of total N & incorporated to 20 cm depth.
- The remaining K and N were side-dressed as eight split doses

Source: 4000-USP-4024-17

AGRONOMY

- Cultural practices such as weed, pest and disease control on all plots were followed the guidelines of University of São Paulo, Brazil

Location/agronomy	Cerquilho 1	Cerquilho 2	Conchal 3
Cultivars:	Norte, Clause®	Norte, Clause®	Arendell from Nunhems®
Population:			
Planting dates:	21-03-2017	21-03-2017	02-03-2017

Fertilizers application

Seedling transplanting

Seedlings

Drip irrigation

CROP GROWTH AND LEAF SAMPLING


March, 16


April, 27

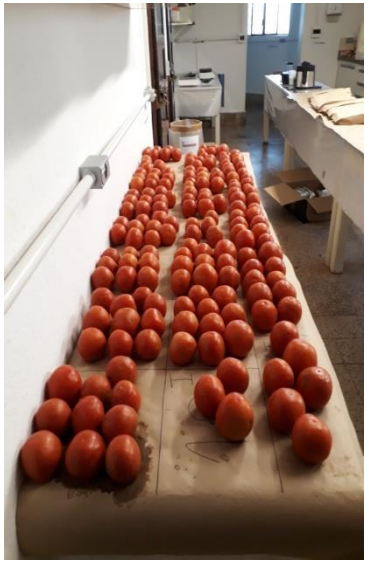

May, 11


June, 08

- Leaves between the third and fourth fruit clusters were collected to determine nutrient concentrations
- K (flame photometric), Ca, Mg (atomic absorption) and S (turbidimetric method by $BaSO_4$)

HARVESTING AND POST HARVEST FRUIT QUALITY PARAMETERS




- Harvesting at half ripe stage (~ 70 – 140 DAT)
- Grades: marketable (1A, 2A, and 3A) and unmarketable (fruits with physiological disorders and symptoms caused by pests and diseases) categories.

Fruit quality parameters

- Fruit pH
- Brix
- Ascorbic acid content
- Titratable acidity
- Fruit firmness

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YIELD AND YIELD ATTRIBUTES

	Yield (t ha^{-1})					
	Total	**Marketable**	**Non-marketable**	**Size class 1A**	**2A**	**3A**
Source						
Control	50.3 B[y]	46.4 B	-	9.0 B	-	-
MOP	53 AB	48.5 AB	-	11.2 A	-	-
POLY4	57.1 A	52.9 A	-	12.5 A	-	-
SOP	55.1 AB	51.2 AB	-	12.0 A	-	-
SOP-M	56.2 AB	51.7 AB	-	12.5 A	-	-
SSP	52.9 AB	49.8 AB	-	11.7 A	-	-
Site						
Cerquilho1	48.4 B	45.1 B	3.7 B	8.8 B	25.4 B	11.3 A
Cerquilho2	40.6 C	37.1 C	3.4 B	7.4 C	22.4 C	7.5 C
Conchal3	73.2 A	68.1 A	5.7 A	18.2 A	40.7 A	9.1 B
p values						
Source	0.0415	0.0436	NS	<0.0001	NS	NS
Site	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Source*site	NS [z]	NS	0.0458	NS	NS	0.0111

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FRUIT NUMBER AND FRUIT WEIGHT

	Fruit number plant $^{-1}$		Average fruit weight, g	
Source	**Total**	**Marketable**	**Total**	**Marketable**
Control	45.1 C	35.4 C	-	-
MOP	48.8 BC	37.5 BC	-	-
POLY4	53.1 A	41.8 A	-	-
SOP	50.9 AB	39.4 AB	-	-
SOP-M	51.8 AB	40.2 AB	-	-
SSP	50.8 AB	38.7 ABC	-	-
Site				
Cerquilho1	51.7 B	40.7 A	94 B	110 B
Cerquilho2	44.1 C	34.1 B	92 B	107 B
Conchal3	54.4 A	41.7 A	122 A	147A
p values				
Source	<0.0001	<0.0018	NS	NS
Site	<0.0002	<0.001	<0.0001	<0.0001
Source*site	NS	NS	NS	NS

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FOLIAR NUTRIENT CONCENTRATIONS, g kg^{-1}

	N	P	K	Ca	Mg	S
Source						
Control	-	3.5 B	25.3 B	-	-	2.7 B
MOP	-	3.6 B	30.4 A	-	-	2.7 B
POLY4	-	3.6 AB	33.3 A	-	-	3.4 A
SOP	-	3.7 AB	31.8 A	-	-	3.1 AB
SOP-M	-	3.7 AB	32.2 A	-	-	3.1 AB
SSP	-	4.0 A	32.1 A	-	-	3.2 A
Site						
Cerquilho1	38.2 B	4.0 A	-[x]	9.0 B	3.4 B	3.4 A
Cerquilho2	39.4 B	3.9 A	-	6.5 C	3.3 B	2.7 C
Conchal3	45.3 A	3.1 B	-	10.7 A	4.1 A	3.1B
p values						
Source	NS	0.0116	0.0001	0.0015	NS	0.0008
Site	0.0005	0.0009	NS	<0.0001	<0.0001	<0.0001
Source*site	0.0906	NS	NS	0.0773	NS	NS

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FRUIT NUTRIENT CONCENTRATIONS, g kg^{-1}

	N	P	K	Ca	Mg	S
Source						
Control	29.3 B	-	-	-	-	1.83 AB
MOP	29.5 B	-	-	-	-	1.78 B
POLY4	30.4 AB	-	-	-	-	1.93 AB
SOP	32.6 A	-	-	-	-	2.17 A
SOP-M	28.9 B	-	-	-	-	2.05 AB
SSP	31.6 AB	-	-	-	-	1.92 AB
Site						
Cerquilho1	32.1 A	5.9 A	40.9 A	1.8 A	2.4 A	2.26 A
Cerquilho2	31.1 A	5.1 B	37.3 A	1.5 AB	2.6 A	1.91 B
Conchal3	27.9 B	3.9 C	31 B	1.4 B	1.9 B	1.67 B
p values						
Source	<0.0049	NS	NS	NS	NS	0.0465
Site	0.0072	0.0002	0.0005	0.0233	0.0011	0.002
Source*site	NS	0.0922	NS	0.0024	NS	NS

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FRUIT QUALITY PARAMETERS

	Ascorbic acid	Titratable acidity	pH	°Brix	
	mg 100 g^{-1}	mg 100 g^{-1}		%	
Source					
Control	-	0.30 C	-		
MOP	-	0.40 AB	-		-
PH	-	0.35 B	-		-
SOP	-	0.37 AB	-		-
SOP-M	-	0.38 AB	-		-
SSP	-	0.41 A	-		-
Site					
Cerquilho1	10.2 B	0.38 A	4.42 B	-	39.8 A
Cerquilho2	10.8 B	0.38 A	4.42 B	-	42.5 A
Conchal3	14.7 A	0.34 B	4.49 A	-	33.8 B
p values					
Source	NS	<0.0001	NS	NS	NS
Site	0.0005	0.0006	0.0189	NS	0.0002
Source*site	NS	NS	NS	NS	NS

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CHANGES TO SOIL FERTILITY

	Changes to soil test values (post-harvest/pre-harvest, mg kg^{-1})					
	pH	**P**	**K**	**Ca**	**Mg**	**S**
Source						
Control	-	-	-	-39 AB	-	-3.3 D
MOP	-	-	-	-57 AB	-	-2.0 CD
POLY4	-	-	-	-33 AB	-	1.4 BC
SOP	-	-	-	-79 B	-	6.2 A
SOP-M	-	-	-	-63 AB	-	1.0 BC
SSP	-	-	-	-27 A	-	2.3 B
Site						
Cerquilho1	-0.91 B	132 A	-	-	-23 A	-
Cerquilho2	-0.99 B	137 A	-	-	-28 A	-
Conchal3	-0.71 A	116 B	-	-	-54 B	-
p values						
Source	NS	NS	<0.0001	0.0414	NS	<0.0001
Site	0.0571	0.0515	0.0288	NS	0.0289	NS
Source*site	NS	NS	0.0691	NS	NS	NS

CHANGES IN SOIL TEST K BY FERTILIZER SOURCE FOR THREE EXPERIMENTAL SITES IN BRAZIL

Location	Control	MOP	PH	SOP	SOP-M	SSP
Cerquilho1	-17 df	164.2 abc	202 abc	160 bc	157.18 bce	152 bce
Cerquilho2	-21 ef	198.6 abc	149 bcd	148 bcd	127.47 cdef	150 abcde
Conchal	-52 f	262.9 abc	350 a	334 abd	179.76 abcde	204 abc

CONCLUSIONS

- Total and marketable yields were higher for PH than the control but all other fertilizers were similar to the control and to POLY4. This result was consistent among the three commercial fields
- The POLY4 treatment had higher fruit numbers than the control and MOP. Yields were highly correlated to fruit number per plant (r=0.84-0.87 suggesting that POLY4 increased fruit set leading to higher yields
- Potassium did increase leaf K, the number of class 1, small fruit (40-50 mm), titratable acidity and soil test K, but not other fruit quality parameters
- Sulphur fertilization increased leaf S. Only the POLY treatment was significantly different to control for foliar S
- Since yields in MOP, SOP, SOP-M and SSP were not different than the control, it did not appear that tomato responded to any single fertilizer nutrient including K, suggesting the response to POLY4 may have been a response to a combination of the S, Ca, and Mg in POLY4

Sustaining the future.

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THANK YOU

Any questions please contact:

Brad,farber@siriusminerals.com

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