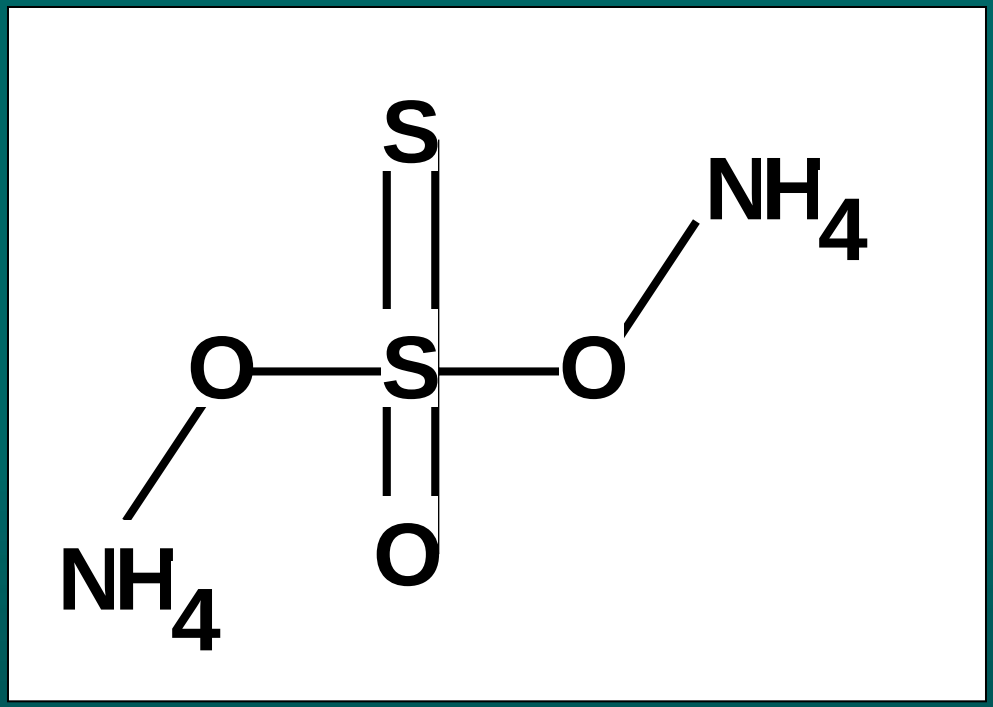
Thiosulfates – Liquid Fertilizer combining Sulfur with other Key Crop Nutrients

Product	Formula	Nutrients	Density	pH
Potassium thiosulfate	$K_2S_2O_3$	25% K_2O & 17% S	1.46	7.0-8.2
Calcium thiosulfate	CaS_2O_3	6% Ca & 10% S	1.25	7.0-8.0
Ammonium thiosulfate	$(NH_4)_2S_2O_3$	12% N & 26% S	1.33	7.2-8.0
Magnesium thiosulfate	MgS_2O_3	4% Mg & 10% S	1.23	6.5-7.5

- All products are homogeneous clear liquids
  - As liquids, dissolution is instantaneous
  - Neutral pH gives wide compatibility with other liquid fertilizers and crop protection products
  - All are odourless and easy to handle



Ammonium Thiosulfate

Fertilizer Product

Ammonium Thiosulfate

$(NH_4)_2S_2O_3$

- 12-0-0-26S
- Typical pH- 7.2 to 8.0
- Compatible with APP and UAN
- Major use- Liquid sulfur addition to UAN and starter fertilizers
- 28-0-0-5S

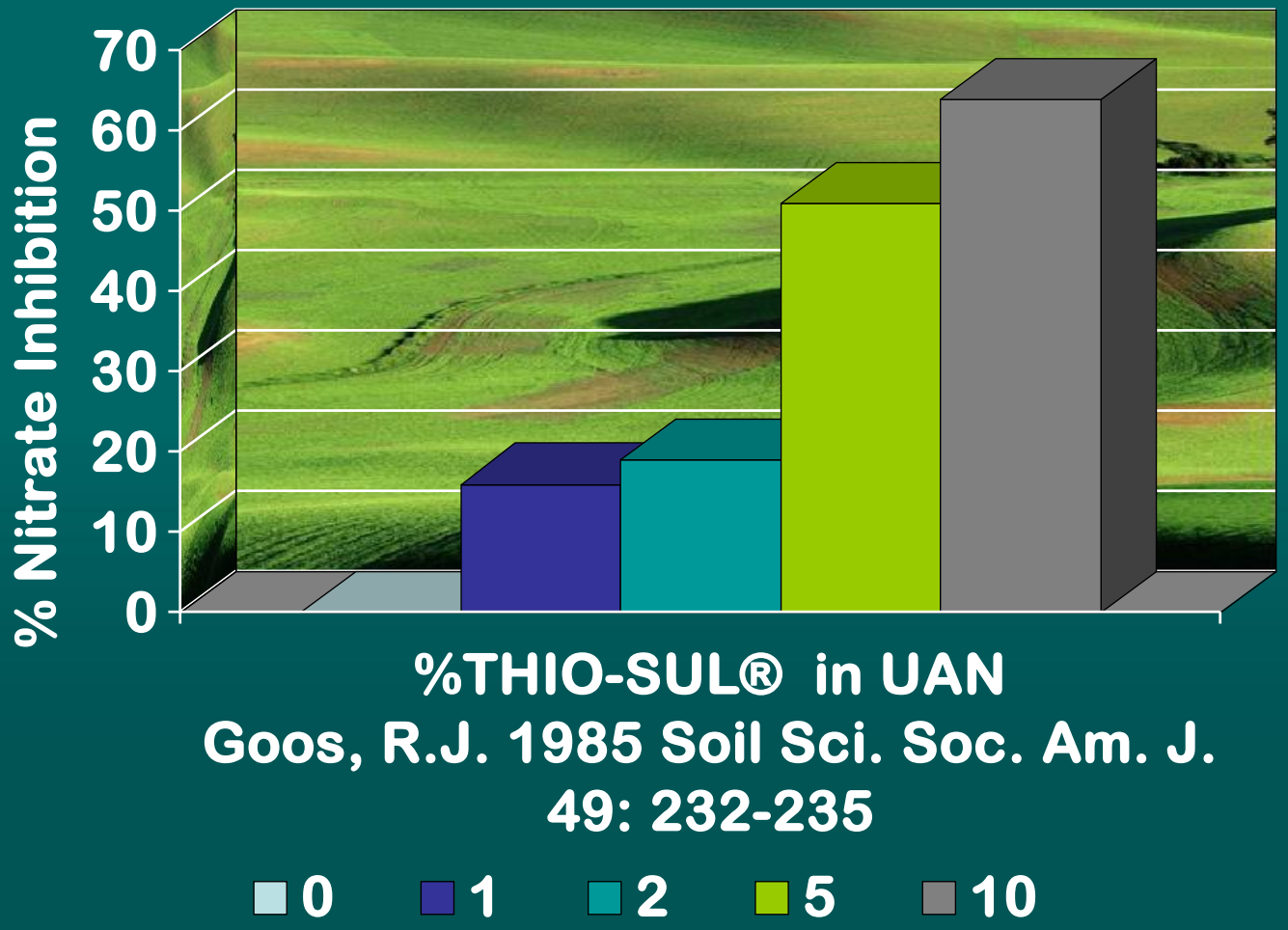
Official Fertilizer Definition*

"Ammonium Thiosulfate (fertilizer grade) is a commercial product composed principally of $(NH_4)_2S_2O_3$. … *It is a nitrification inhibitor*."

** Official Publication, Association of American Plant Food Control Officials, No.55, 2002. (Emphasis added.)*

BROADCAST

Nitrification Inhibitor Effect on UAN



THIO-SUL® compared to N-Serve™

		Soil NH_4-ppm N		Wheat	
Treatment	Liters/ha	21 DAT	7 MAT	Yld. Kg/ha	% N Recovery
Control	0	32	0	2486	24
N-Serve™	2.4	63	19	3024	50
N-Serve™	7.1	68	32	3084	50
THIO-SUL®	49.4	54	13	3178	56
Least Significant Difference	*.02*	*11*	*9*	*282*	-

Goos, R.J. and B.E. Johnson. 1999 Agron. J. 91: 1046-1049

(N-Serve™ is a trademark of Dow AgroSciences LLC.)

THIO-SUL®
compared to AGROTAIN®

Treatment	Ammonia Loss (mg N)
UAN	49.81
UAN + ATS @ 10%	25.99
UAN + AGROTAIN® (NBPT) @ .25%	16.54

Grant, C.A. 1996. Can J. Soil Sci. 76: 417-419

(AGROTAIN® is a registered trademark AGROTAIN International LLC.)

ATS Fertigation

Sprinklers:

- – 1 to 5 gal/acre for vegetables and row crops
- - 5 to 10 gal/acre Trees
- - 2 to 4 gal/acre Vines

Flood:

- 5 to 10 gal/acre for row crops, vegetables, trees and vines

ATS Fertigation

Drip:

- Drip tape & subsurface drip – 1 to 2 gal/acre for vegetables and row crops
- Subsurface - 2 to 4 gal/acre Trees & vines
- Drippers & mini sprinklers - 6 to 8 gal/acre for trees & vines

Calcium Thiosulfate

- Chemical Formula - CaS_2O_3
- Clear Liquid
- 6% soluble Calcium (0.63 lbs/gal)
- 10% sulfur as thiosulfate (1.04 lb/gal)
- 10.4 lbs/Gallon (191.8 gals/ton)
- pH = 7.0

CaTS Soil Amendment

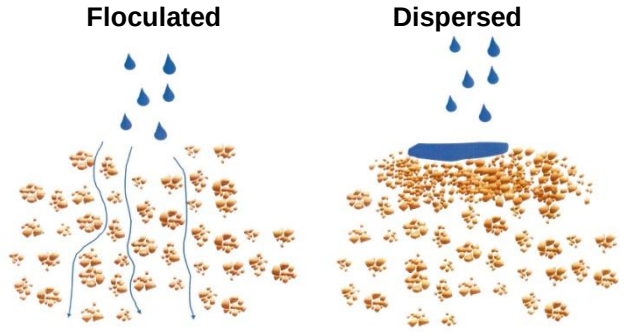
Sodic Soil:

$$CaS_2O_3 + 2O_2 + CaCO_3 + 4NaX \longrightarrow$$

$$2CaX + 2Na_2SO_4 + CO_2$$

Calcium Thiosulfate for Soil Ammendment

- Calcium thiosulfate can improve soils by
  - Displacing bound potassium making it available to the plants
  - Improving water infiltration via floculation in soils where sodium levels are high enough to defloculate soil clay particles
  - And/or where irrigation water is low in salts having an electrical conductivty (EC) of below 0.4 mmhos/cm
  - Defloculated (dispersed) soil clay particles plug soil pores impeding water infiltration and soil drainage

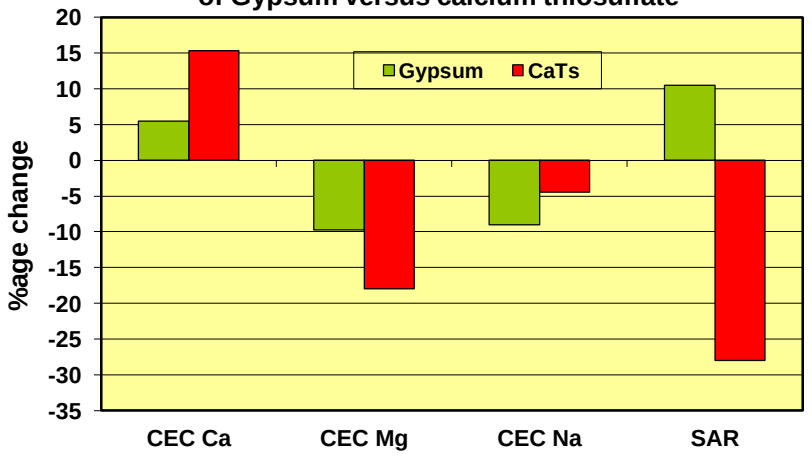


- Soil ammendement trial
  - One acre of citrus grove treated
  - Weekly treatment over 10 weeks
  - 1 gal/ac CaTs verus 1500 lbs/ac gypsum

Comparison of water soluble calcium in gypsum vs calcium thiosulfate

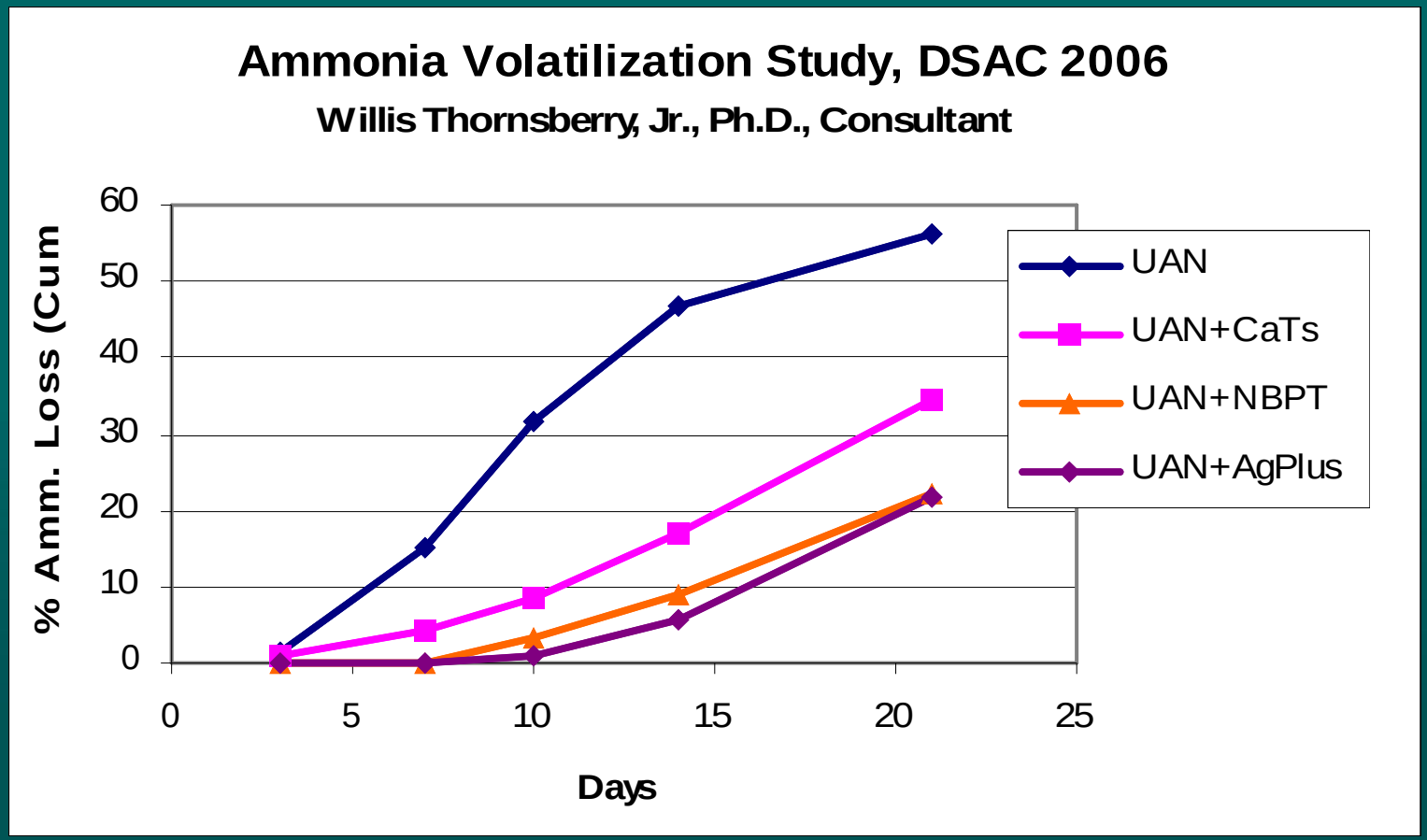
	% Ca	Solubility (%)	Kg Soluble Ca / mT product
Gypsum	23	0.2	0.46
Calcium thiosulfate	6	100	60

Changes in soil analysis after 10 weekly applications of Gypsum versus calcium thiosulfate



Gypsum	5.5%	-9.7%	-9%	10.5%
CaTs	15.3%	-18%	-4.5%	-28%

CaTs Ammonia Volatility Study, Univ. of Illinois



Bringing Chemistry to Life

CaTs Application Rates

- **Sprinkler Irrigation:**

  - Young trees and vines: 3 – 8 gal/acre
  - Mature trees and vines: 5 – 10 gal/acre

Flood and Furrow:

  - Row crops: 10 – 15 gal/acre
  - Trees and vines: 10 – 15 gal/acre

Drip Irrigation:

  - Young trees and vines: 4 – 8 gal/acre
  - Mature trees and vines: 5 – 10 gal/acre
  - Vegetables and row crops: 3 – 5 gal/acre

KTS®

Potassium thiosulfate

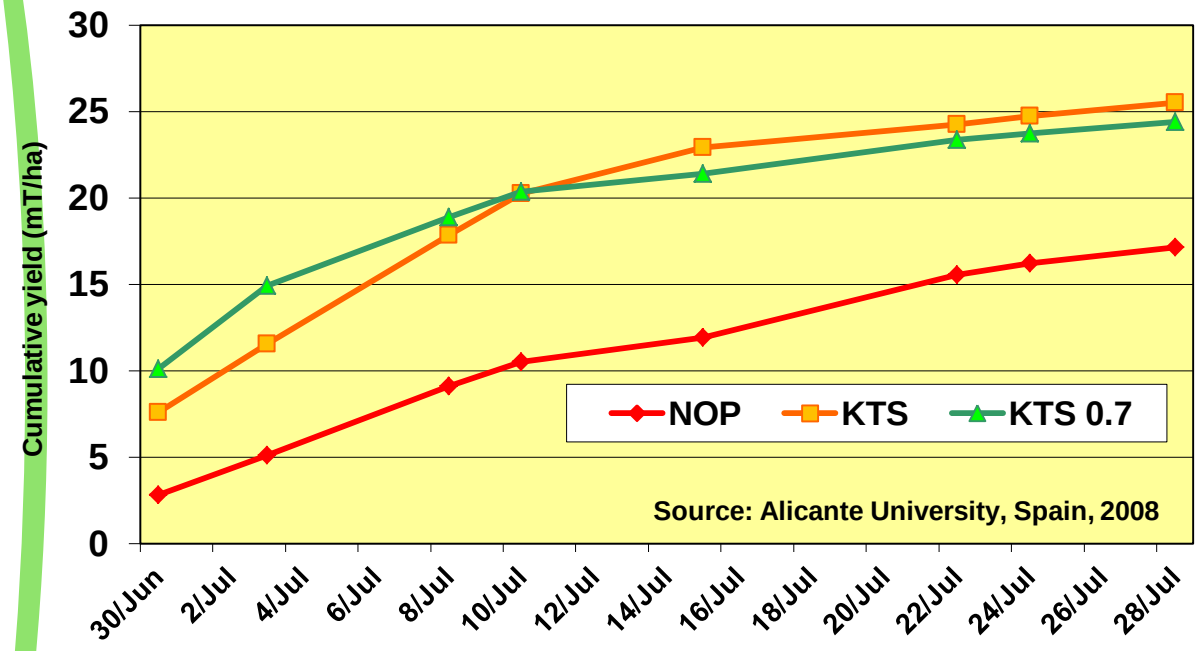
0-0-25-17S

Clearly Superior

KTS (0-0-25-17S)

Plant Nutrient content wt. %	
Soluble Potash	25.0
Total Sulfur (S)	17.0
Typical Properties	
Specific Gravity	1.46
pH	7.0 - 8.0
Appearance	Clear
Salting Out Temp., ^{0}F	<15

Potassium Thiosulfate Fertilization of Melon



Treatment program

- 200-100-350 kg/ha N, P_2O_5 and K_2O respectively. (KTS 0.7 = 245 K_2O kg/ha)
- Fertilization by drip irrigation (cucumis melon cv Alps)

KTS 0.7 treatment gave an additional 7.27 mT fruit yield per hectare

- Value of additional yield from KTS 0.7 compared to NOP is approximately 2900 euro/ha (for 0.4 euro cents/kg melon)
- Treatment cost of 0.7 KTS approximately 400-600 euro/ha more than NOP treatment cost (based on *today's* prices)

Table 2. Effects of foliar potassium (K) sources (potassium chloride – KCl, potassium nitrate - KNO_3, Monopotassium phosphate – MKP, potassium sulfate - K_2SO_4, potassium thiosulfate - KTS, and Potassium Metalosate - KM) on the yield, average fruit weight and fruit firmness of field-grown muskmelon ('Cruiser') fruit. Weekly foliar K applications were made between fruit set and fruit maturity during the spring growing season in 2006 and 2007.

Treatment	Yield		Fruit Weight		External Fruit firmness		Internal Fruit firmness	
	40lb-boxes/acre		(g)		(N)		(N)	
	2006	2007	2006	2007	2006	2007	2006	2007
Control	144.5a[z]	455.9b	1826.3a	2148.4a	41.7b	41.2a	10.2bc	8.9b
KCl	148.8a	506.2a	1867.5a	2295.7a	43.0b	44.7a	10.6abc	9.9ab
KNO_3	136.1a	429.9b	1770.9a	2191.3a	39.6b	39.9a	9.8c	8.4b
MKP	160.2a	530.0a	1763.7a	2384.7a	43.3b	46.1a	11.2abc	10.9a
K_2SO_4	155.8a	517.0a	1977.8a	2298.1a	57.8a	45.2a	12.8ab	10.3ab
KTS	166.9a	573.9a	1805.2a	2496.0a	51.8ab	46.8a	13.1a	11.1a
KM	151.4a	521.9a	1936.3a	2337.4a	43.6b	45.7a	11.2abc	10.7a

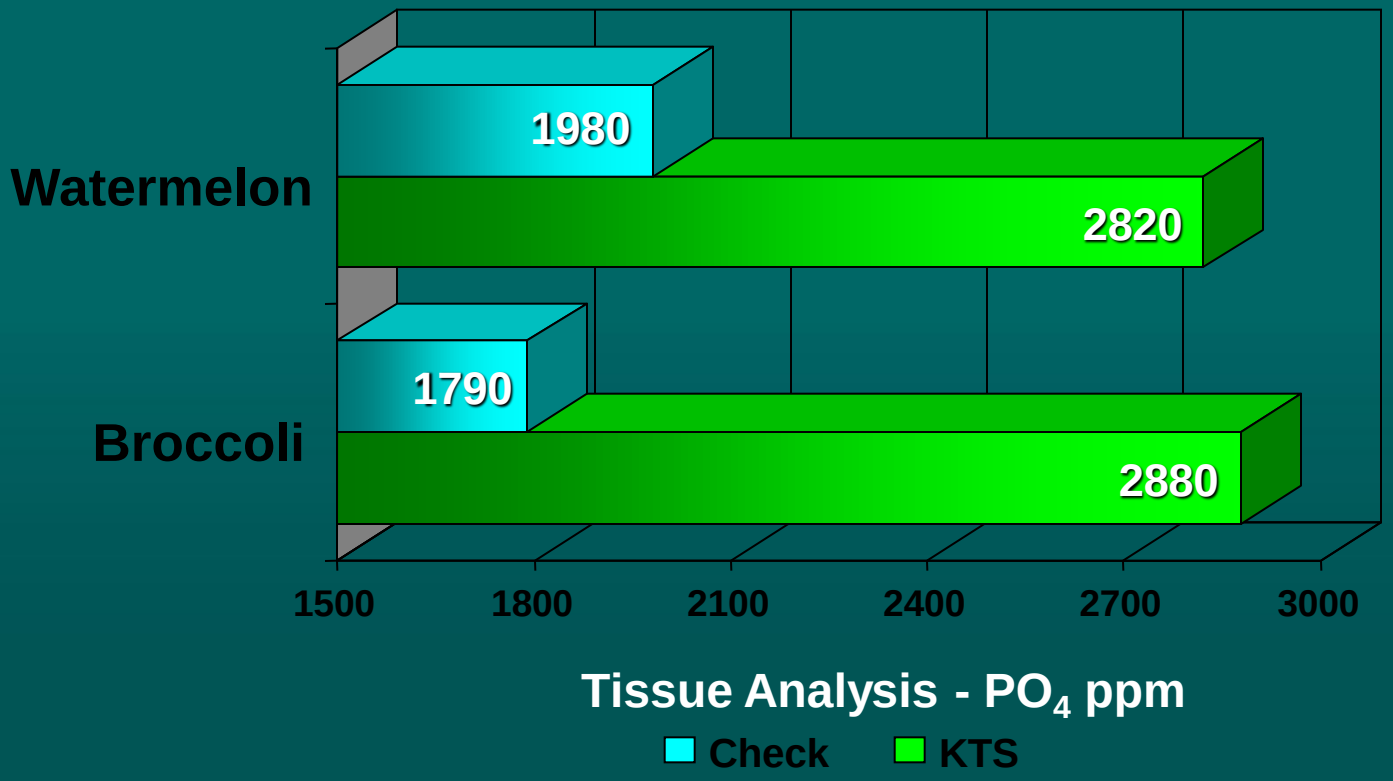
[z] Means with the same letter, within a column and location, are not *significantly different at Duncan's MRT 95% probability level (n=6*-16).

Fungicide Trial

Effect of KTS™ on Phosphate Nutrition

Arizona - Subsurface Drip Irrigation

KTS Injected 3.0 gal/ac, 2 applications, 10 days apart



KTS vs SOP

K-Source	Rate (lbs K_2O/Vine)	Injection Time	% K in petiole at bloom
KTS	0.18	0.5 hrs	1.89
K_2SO_4	0.18	1.5 hrs	1.55
K2SO4	1.8	3.0 hrs	1.41
Check			1.33

Roach Vineyard Salinas, CA. 2002

KTS Almond Trial

	K Source		
Treatment	60% SOP 40% KTS	100% SOP	100% KCL
	200 lbs/ac K	200 lbs/ac K	200 lbs/ac K
Drip Irrigation	Yield kg/ha		
	4,403	3,883	4,157
	A	B	AB
Fan Jet Irrigation	4,278	4,047	3,771
	A	B	C

U.C Davis, Patrick Brown

KTS Application Rates

Sprinkler:

Young trees and vines: 3 – 5 gal/acre
Vegetable and row crops: 3 – 5 gal/acre

Flood & Furrow:

Trees and vines: 10 – 15 gal/acre
Vegetable and row crops: 10 – 15 gal/acre

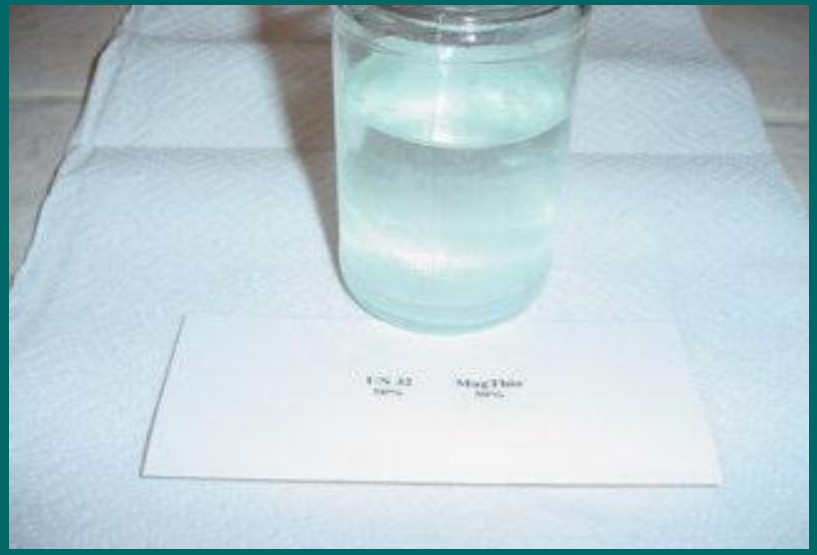
Drip Irrigation:

Young trees and vines: 3 – 5 gal/acre
Mature trees and vines: 5 – 10 gal/acre

Magnesium Thiosulfate Liquid

MagThio

MgS_2O_3



Mg	4.0%
S	10%
Wt. per Gal	10.0
pH	6.5 – 7.0

MagThio Potato Trial

Treatment #	Check	6 gal/ac	3 gal/ac – 2 times	1,2 and 3 gal/ac
Total Yield/ac	33.66	38.02	42.65	43.72
Total Usable Yield/ac	31.44	35.5	40.68	41.14

MagThio Carrot Trial

Treatments	Rate/ac	# of Applications	Timing Growth stages, inches	Yield Ton/ac	Yield Increase Over Check
1.) Grower's Standard	-------	--------	--------	73.5	-------
2.) MagThio - foliar	1.0 gal	3	6", 20" & 23"	79.3	+5.8 tons/ac
3.) MagThio - foliar	2.0 gal	3	6", 20" & 23"	84.4	+10.9 tons/ac
4.) MagThio, - foliar	3.0 gal	3	6", 20" & 23"	89.5	+16.0 tons/ac
5.) Mag sulfate, - soil	20 lbs of Mg broadcast, preplant	1	----------	77.6	+4.1 tons/ac

Magnesium Thiosulfate Effect on Barley Scab

Treatment	Net Blotch % Severity	Head Scab % Incidence	Yield Bu/ac	Test wt Lbs/bu
1.) Untreated Check	8.7	58.23	86.2	46.83
2.) Caramba	4.27	33.33	91.0	47.03
3.) Caramba + MagThio 1.0 gal/ac	2.97	25.57	95.5	46.85
4.) Caramba + MagThio 2.0 gal/ac	3.9	28.9	91.3	46.8
5.) Prosaro	2.23	28.9	94.4	47.03
6.) Prosaro + MagThio 1.0 gal/ac	1.8	20.0	92.8	47.13
7.) Prosaro + MagThio 2.0 gal/ac	1.13	15.57	97.0	47.35

MagThio Application Rates

Sprinkler:	Young trees and vines: 2 – 4 gals/acre
	Mature trees and vines: 3 – 6 gals/acre
	Row crops: 3 – 10 gals/acre
Drip:	Young trees and vines: 4 – 6 gals/acre
	Mature trees and vines: 5 – 10 gals/acre
	Vegetable and row crops: 3 – 5 gals/acre
Foliar:	Vegetables and row crops: 3 – 5 qts/acre
	Tree crops: 2 – 4 qts/acre
	Vines: 2 – 4 qts/acre
	Citrus: 4 – 8 qts/acre

Thiosulfates

They don't like acids

Highly soluble so taken up fast

Fertigation injection – as long as possible, avoid extreme heat

Foliar applications – avoid hot days or afternoons

Storage – water loss during hot periods

Follow directions on the application guides

All recommendations are for Thiosulfates only