Sulphur Fertilizer Effect on Crop Development & Quality

Sulphur Play a key role in:

- **Chlorophyll (Photosynthesis)**
  - a key ingredient in the formation and ***sulphur deficient plants can be 40% lower in chlorophyll.***
- **Nitrogen fixation** - Legumes and soil bacteria
- **Enzymes** and Coenzymes
- **Hormones**
- **Glycosides**
  - Give taste and odor to plants in the mustard and onion families.
- **S-containing sulfolipids** (oil synthesis)
- **Vitamin production**

Lack of Chlorophyll with deficient tomatoes on left

Sulphur Fertilizer Effect on Crop Development & Quality

Reduction of Nitrates and Non-protein N

- Plants deficient in S accumulate non-protein N
  - In the form of NH_2, and NO_3^-
- Especially important for forages and the reduction of nitrates in the feed.
- A N/S ratio of 9-1 and 12-1 is needed for effective use of N by Rumen micro-organisms
- Research has shown that sulphur-deficient forage crops, when fed to livestock, can actually reduce

Sulphur improves feed "Quantity & Quality"

Rate of S (kg/ha)	Yield (T/ha)	Sulphur (%)	Protein (%)
0	3.95	0.10	8.8
34	10.37	0.21	18.8
67	12.84	0.23	21.3

Source:

Agriculture Canada, Brandon, Manitoba, Canada

Sulphur Fertilizer Effect on Crop Quality

- **Sulphur Fertilizer Effect on Reduction of Nitrate:**
  - Sulphur fertilization **reduced nitrate** concentration in various leaf **vegetables by 10% to 50%** in Anhui, Fujian, and Guangdong Provinces

- **Sulphur Fertilizer Effect on Synthesis of Oil:**
  - Sulphur fertilization **increased oil** content of **Soybeans by 6.5%** in Indiana, USA.

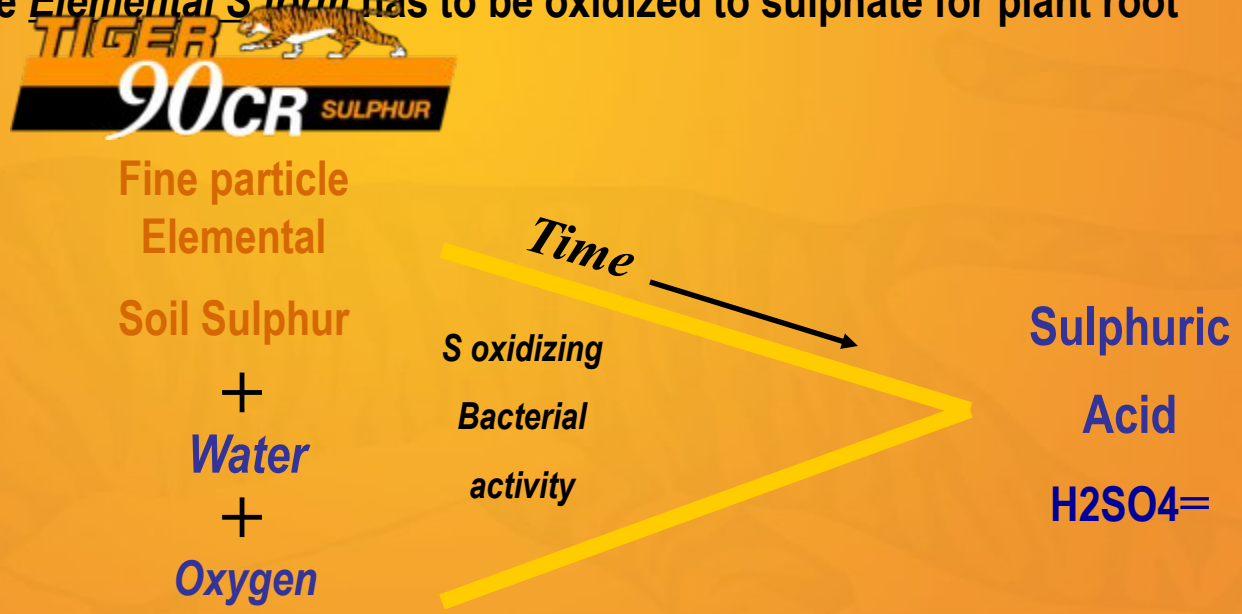
The Sulphur Institute 1997 - 2003 S trials

The movement of Sulphur into plants.

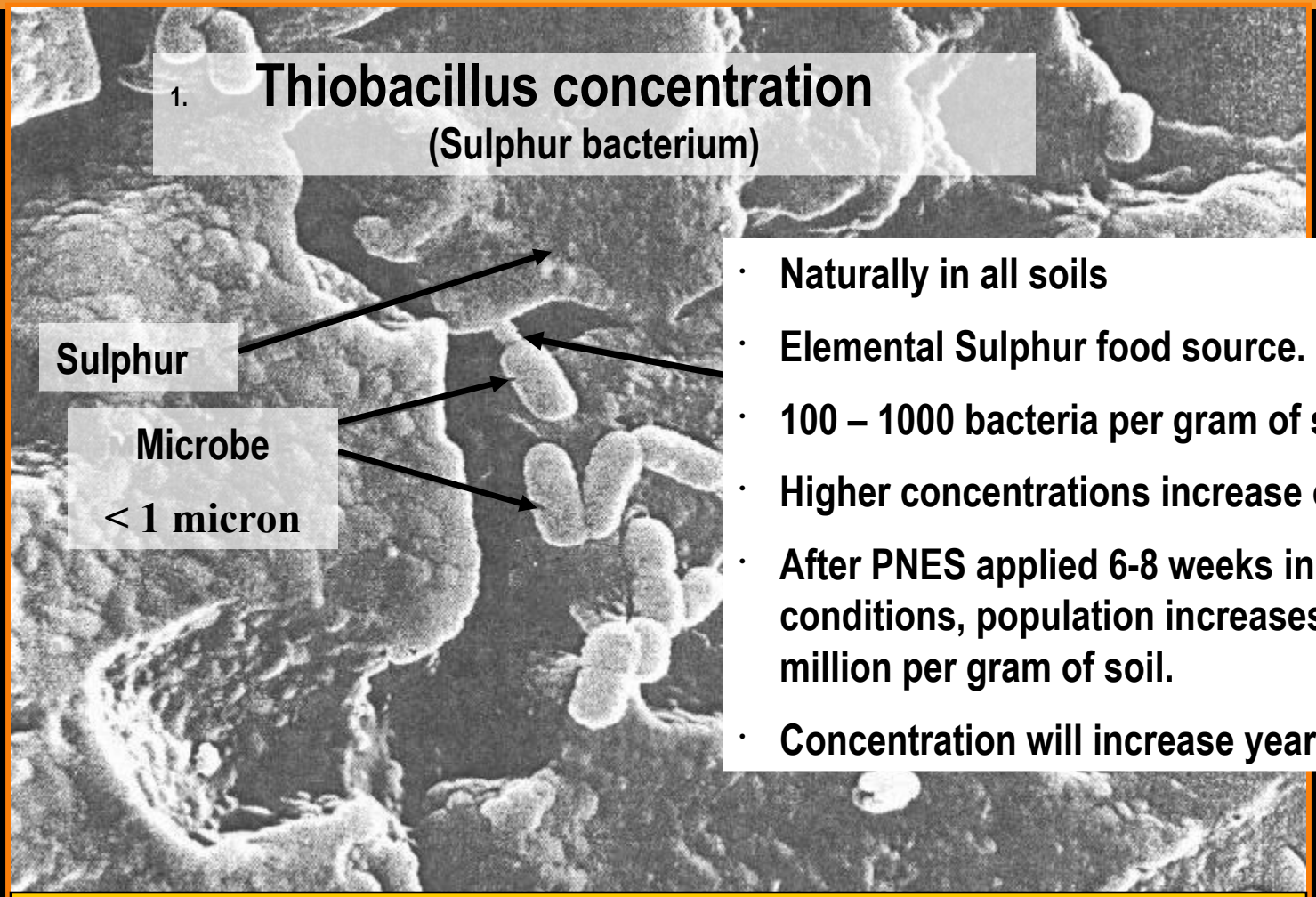
Uptake of S

- Plants take sulphur from the soil in the sulphate form ($SO_4^=$)

- **Sulphur in the *Elemental S form* has to be oxidized to sulphate for plant root uptake.**



Key Factors for Oxidization of Elemental Sulphur (PNES)

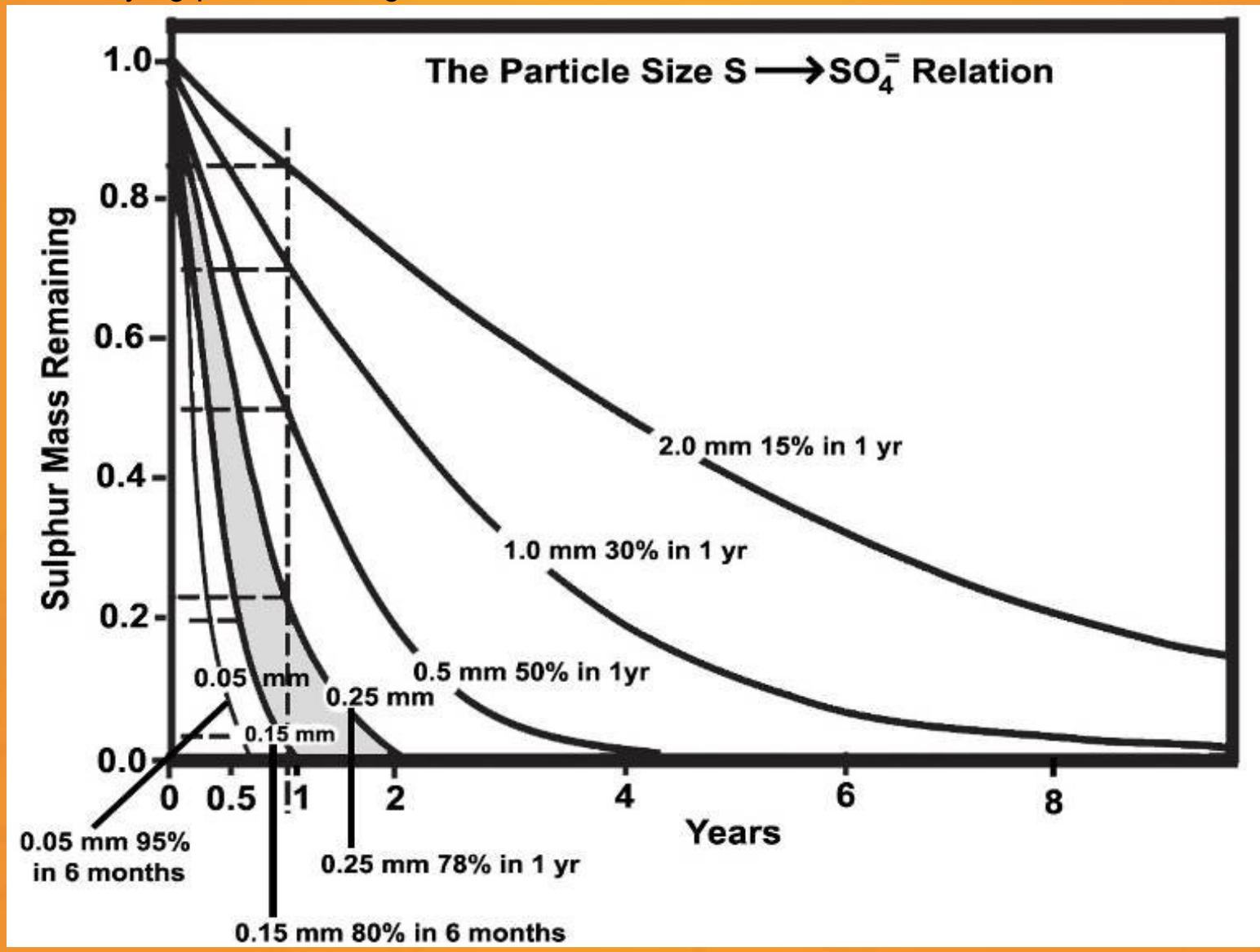


- Naturally in all soils
- Elemental Sulphur food source.
- 100 – 1000 bacteria per gram of soil
- Higher concentrations increase oxidation
- After PNES applied 6-8 weeks in good soil conditions, population increases to approx. 3-3.5 million per gram of soil.
- Concentration will increase year after year.

Scanning Electron Micrograph Showing Thiobacillus attached To Sulphur Particle

Elemental sulphur particle size

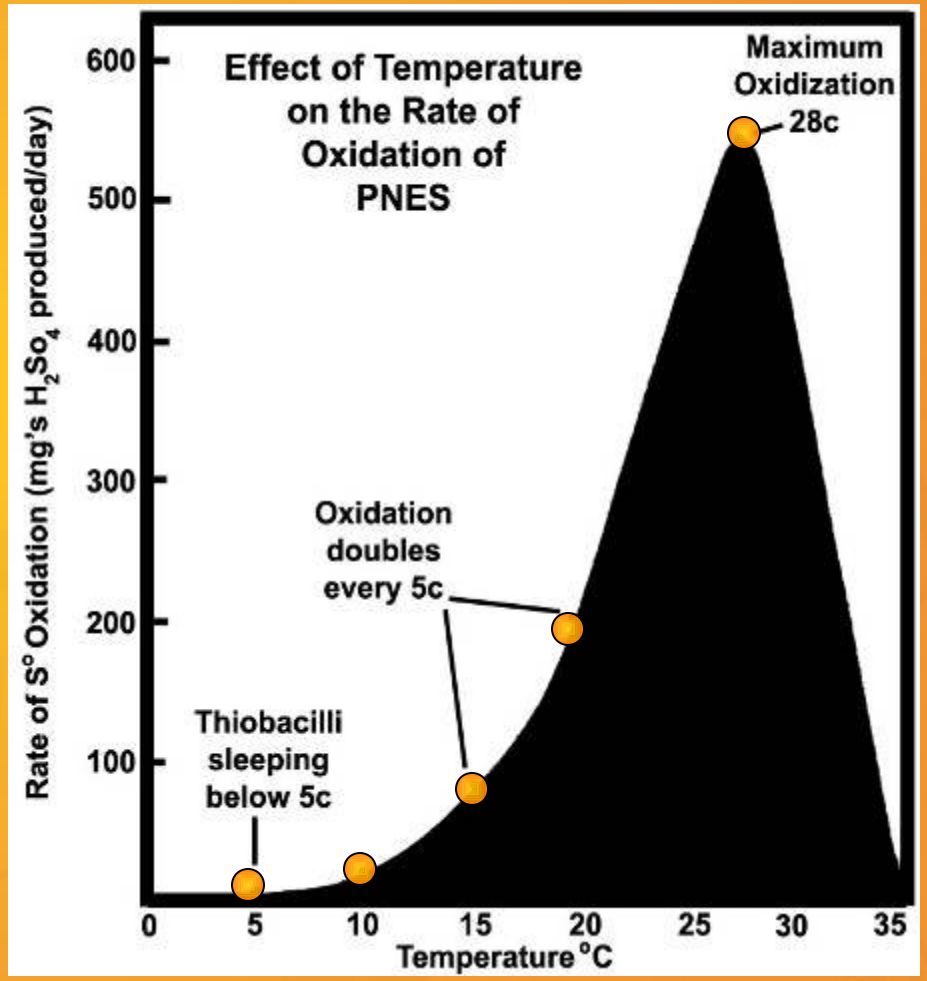
- Varying particle sizing oxidize at different rates due to surface area.



Key Factors for Oxidization of Elemental Sulphur (PNES)

3. Soil Temperature

- The warmer the soil, the faster the PNES is converted to SO4=
- Maximum oxidization 30 C
- Thiobacilli double oxidization every 5 C
- Little Oxidization below 10 C
- Thiobacilli inactive at 5 C



5 Key Factors for Oxidization of Elemental Sulphur (PNES)

5. Oxygen - soil oxidizing bacteria are mostly aerobic

- The conversion from PNES to SO_4 requires oxygen, deep banding slows conversion due to the lack of Oxygen.
- Dry and Water logged soils also slow conversion.

Conversion

	Elemental S	S	0.0 oxygen / Sulphur
	Thiosulfate	-S2O3-	1.0 oxygen / Sulphur
	Tetrathionate	S4O6=	1.5 oxygen / Sulphur
	Trithionate	S3O6=	2.0 oxygen / Sulphur
	Sulphite	SO3=	3.0 oxygen / Sulphur
Sulphate		***SO4=***	***4.0 oxygen / Sulphur***

Surface applications or shallow seeding provides optimum oxygen availability

5 Key Factors for Oxidization of Elemental Sulphur (PNES)

1. Microbial activity – Thiobacillus population repeat S applications have higher Thiobacillus populations
2. Particle Size – Sulphur needs to be broken down into fine particles to increase surface area for Thiobacilli
3. Soil Temperature – Oxidization occurs at >5°C, significantly at 15°C maximum oxidization around 30°C
4. Soil Moisture – Moist soil promotes oxidization Dry and flooded soils slow oxidization.
5. Oxygen – Needs to be present for conversion. Placing sulphur deep into soil reduces $SO_4^=$ production.

Soil Oxidizing bacteria prefer moist warm Soil

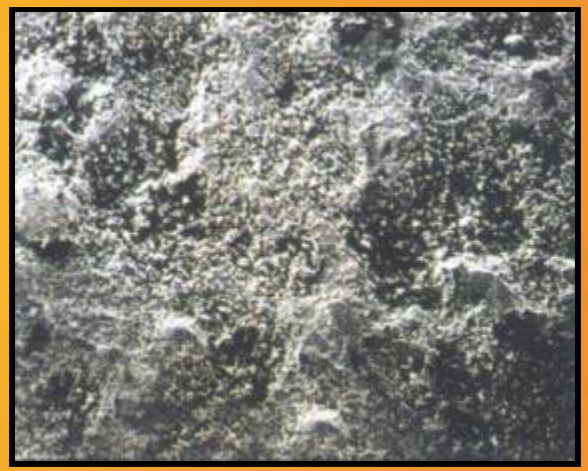
Key Factors for Oxidization of Elemental Sulphur

2. Elemental sulphur particle size

- The finer the particle size the quicker the PNES is converted to SO4=

T90CR pastille

T90CR water added



T90CR fine powder

TIGER™ 90CR Sulphur Bentonite Sulphur vs. Elemental Sulphur.

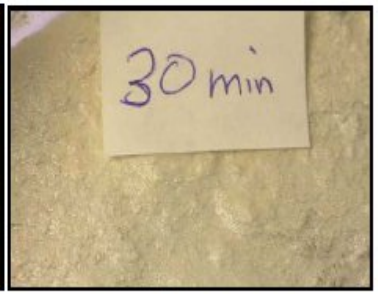
Elemental Sulphur 99.8%

TIGER™ 90CR Bentonite Sulphur

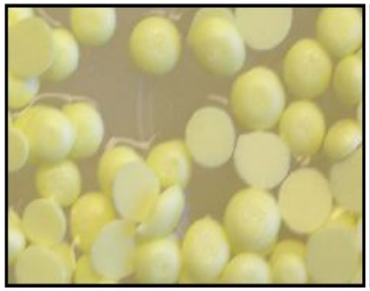
WET- Elemental Sulphur 99.8% – 5 min

WET - TIGER™ 90CR Sulphur – 5 min

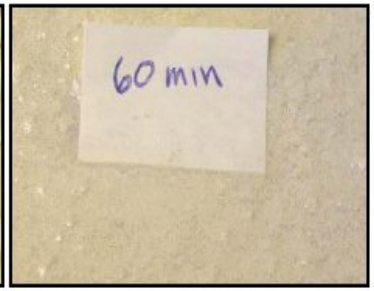
WET- Elemental Sulphur 99.8% – 30 min



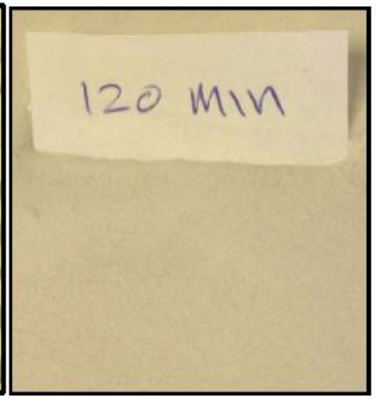
WET - TIGER™ 90CR Sulphur – 30 min



WET- Elemental Sulphur 99.8% – 60 MIN



WET – TIGER™ 90CR Sulphur – 60 MIN

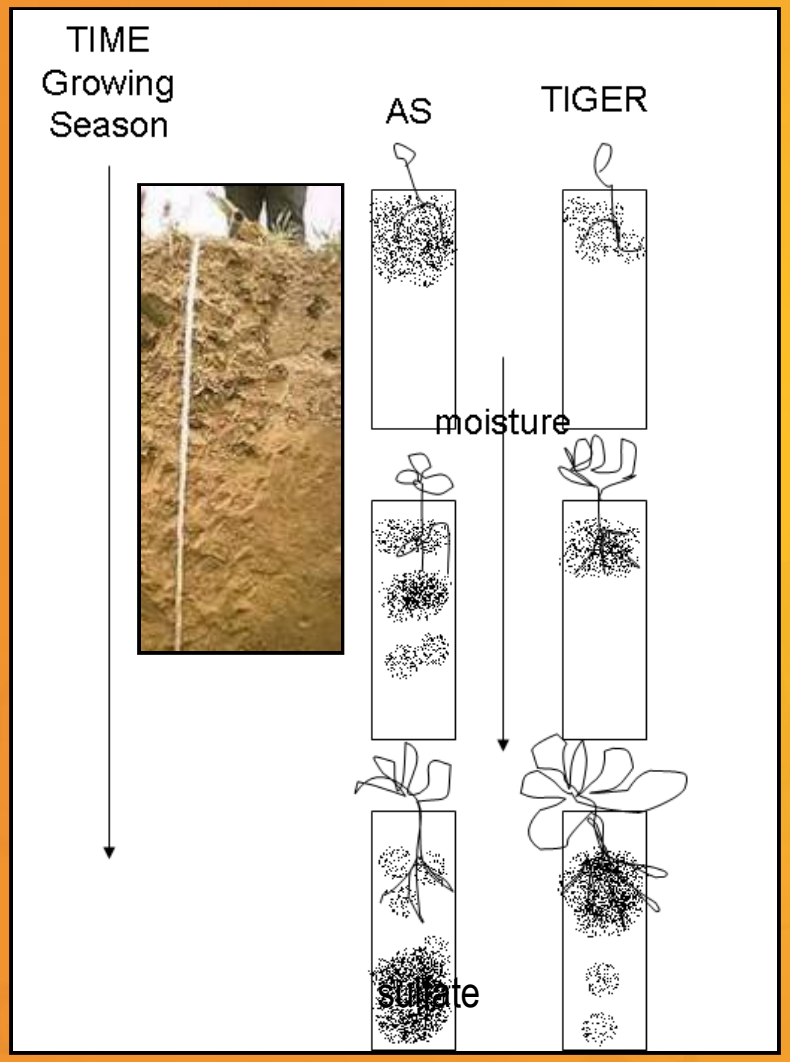


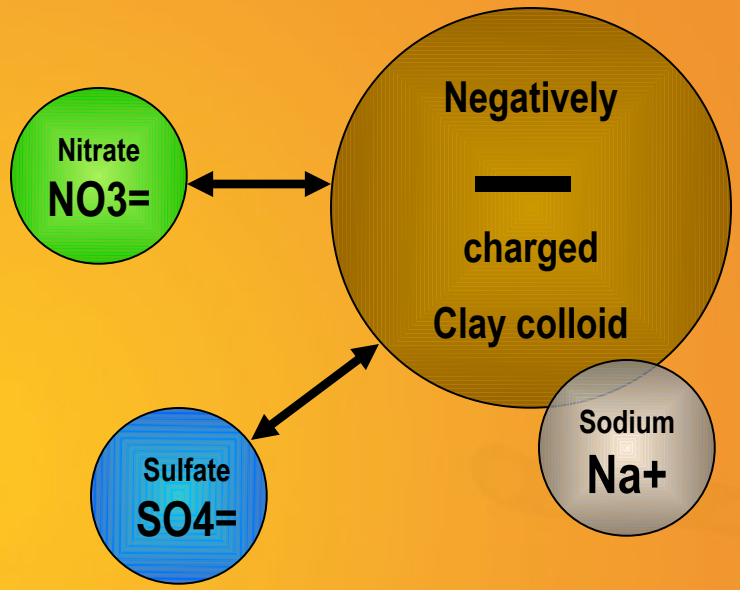
Pictures above showing samples of both materials at 120 minutes. TIGER™ 90CR Sulphur portion is fully degraded into fine particle elemental sulphur that will oxidize rapidly during the growing season.

WET – Elemental Sulphur 99.8% – 24 Hour

WET – TIGER™ 90CR Sulphur – 24 Hour

Sulfate in the Soil



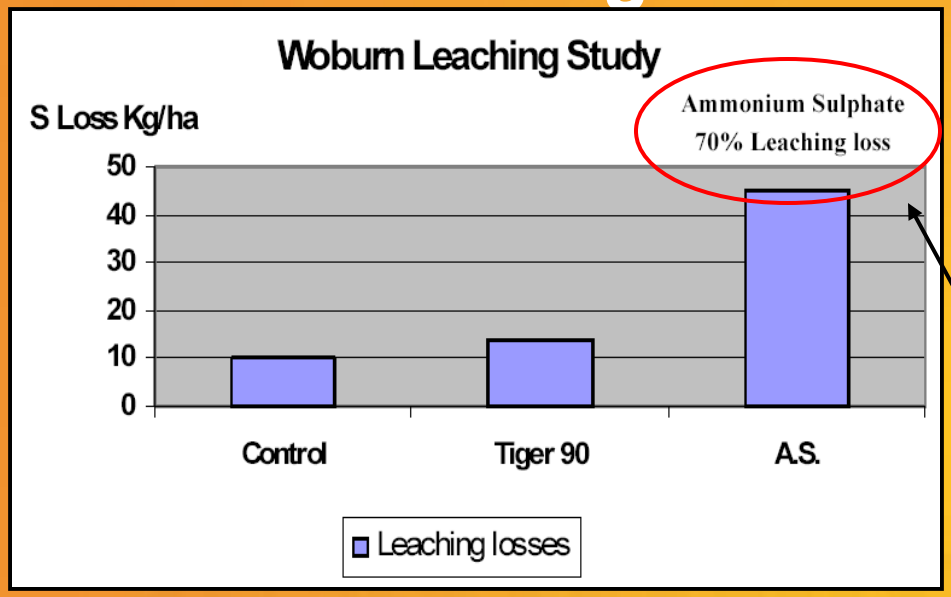


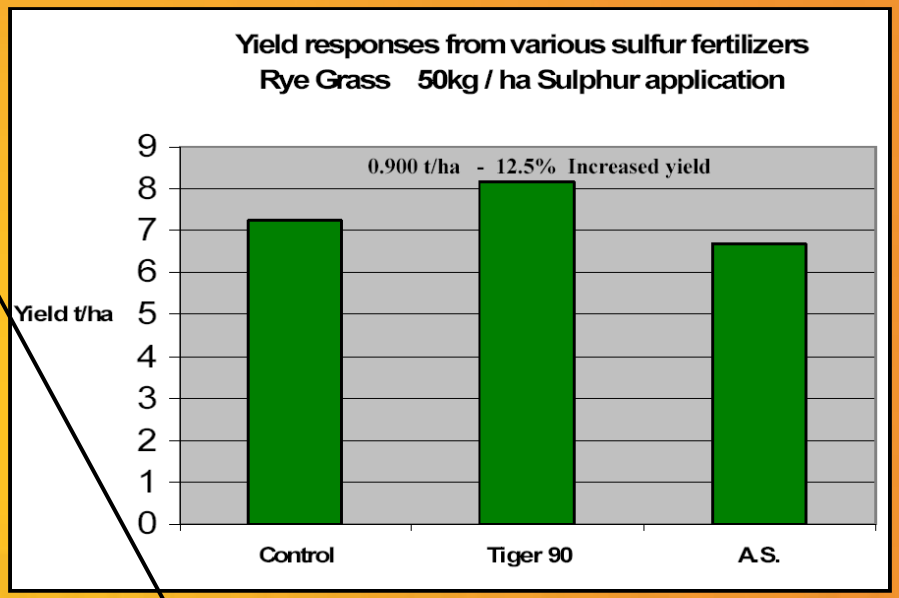
Sulfate fertilizers are prone to leaching:

- Sandy / Loam soils
- Heavy rainfall events.

Tiger 90CR does not leach as it is not water soluble. Needs to be converted to SO_4=. Leaching losses are minimized.

Leaching losses can be dramatic on light textured soils.





- IARC – Rothamstead, England – research station
- Crop – Rye Grass
- Sandy Loam Soil
- 50 kg/ha actual Sulphur broadcast.

- **Ammonium Sulfate** losses were **70%**

Tiger Micronutrients™

Acid Micro-Site Micronutrients

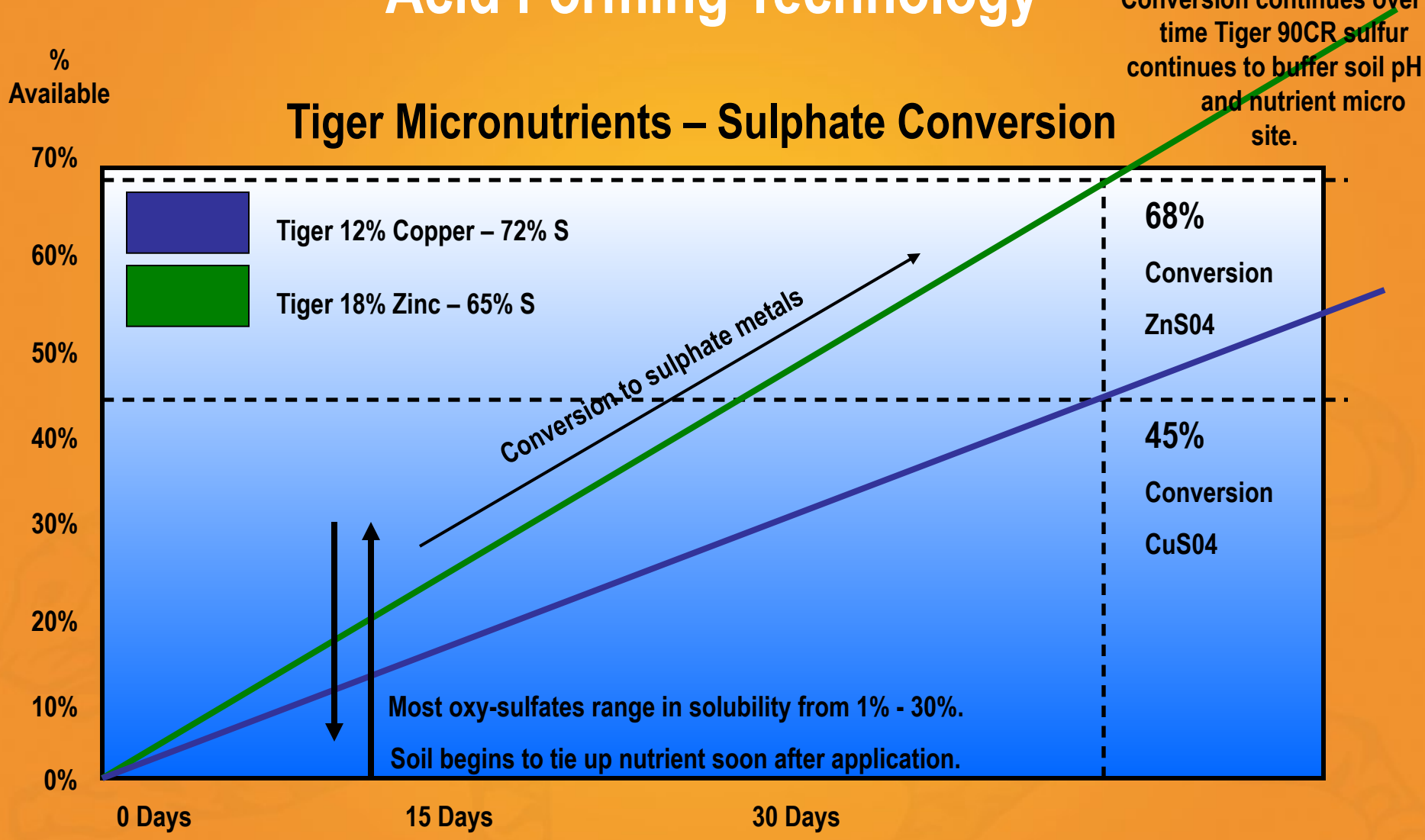
Tiger Sulphur + Air + Water + S oxidizing bacteria → Sulfuric Acid

High Purity Metal Oxide + Sulphuric Acid → Metal Sulfate

Insoluble → **Soluble and Plant Available**

Result → Controlled Release Sulfates

Tiger Micronutrients
"Acid Forming Technology"



Tiger lab testing 22c

TIGER MICRONUTRIENTS
Tiger Sulphur + Micronutrients

TIGER-SUL

Tiger line Of Products

Tiger micronutrient Product	% actual Micronutrient	% Tiger 90CR Sulfur
Boron (B)	2%	80%
Copper (Cu)	7% & 12%	80% & 72%
Zinc (Zn)	4% - 18%	80% & 65%
Manganese (Mn)	15%	53%
Iron (Fe)	22%	55%
Custom Blends (Cu,Zn,Mn,Fe,)	Tiger Corn Mix, Tiger Cotton Mix, Tiger Rice Mix Tiger Cane Mix, Tiger Potato Mix, Tiger Turf Mix	

TIGER MICRONUTRIENTS

Tiger Sulphur + Micronutrients

TIGER-SUL

Tiger Micronutrient Advantage

1. ***Improved Soil Distribution*** **– better plant access to nutrients.**
2. ***Ultra Low Heavy Metal Contents*** **– pure grade metals for environment.**
5. ***Organic Listed Nutrients*** **– Consumers demanding organic.**
6. ***Quality -*** **> 95% uniformity, dust free formulations.**
7. ***Dual Nutrient Formulations*** **– Micronutrient & Sulfur value.**
8. ***Resists Leaching*** **– safer for lakes, rivers, water supplies.**
9. ***Efficient*** **– Constant feeding of micronutrient. (Micro site Acid forming.)**