
Nutrico
Better Growth, Better Yield, Better Value
NUTRIENT USE EFFICIENCY
Martin Botha

BACK TO THE FUTURE WITH BASICS

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THE FACTS

1. WORLD POPULATION NOW MORE THAN 7 BIL., OVER 9 BIL. BY 2050 (FAO 2013)
2. 1.54 BIL. HA LAND UNDER PERMANENT CROPS (FAO 2013)
3. 90% SOILS DEFICIENT OF ESSENTIAL NUTRIENTS MOST CONTAIN TOXIC ELEMENTS
4. 4 BIL. HA ICE-FREE LAND HAVE SOIL ACIDITY PROBLEMS
   950 MIL HA LAND IS SALT AFFECTED
5. PRIMARY FERTILIZER USE:
   105 MIL. TON N, 20 MIL. TON P, 23 MIL. TON K (FAO 2013)
6. RECOVERY & EFFICIENCY:
   < 50% FOR N, < 10% FOR P, < 50% FOR K (BALIGAR 1986)

WHAT IS AGRICULTURE FACING

- **The Biggest Challenge for Agriculture**
  - Improve crop production to feed an expanding world population
- **The Pressure on Agriculture**
  - Limited geographic regions suitable for agriculture
  - Climate change's impact on growing conditions
- **Adverse Effects as result of Agriculture**
  - Damage to the environment
  - Large carbon footprint
  - Use of non-renewable resources
- **How do we solve the Challenges, Pressure & Effects?**
  - Increase land area for agriculture
  - Increase production while maintaining current rate of inputs
  - Increase yield, decrease inputs, decrease resistance to abiotic and biotic stresses
  - Reduce environmental damage from agricultural inputs

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"IMPROVE CROP NUTRIENT USE EFFICIENCY"

PRESENTATION FOCUS
NUTRIENT CAPTURE EFFICIENCY (NUcE)

- NUcE = dry matter produced per unit nutrient applied
- NUcE is essentially a root trait. Increased root volume > NUcE
- **NUcE is affected by:**
  - **Nutrient availability**
  - **Root architecture**
  - **Root function**
  - **Symbiotic associations**

INFLUENCES ON NUcE

NUcE = A MEASURE HOW WELL PLANTS USE AVAILABLE NUTRIENTS

Uncontrollable → **Controllable**

Light
Temp
Moisture
Soil
Cultivar

Fertilizer
Lime
Pesticides
Irrigation
Tillage
Culture
Genetics

DESIGNING THE NEXT GENERATION FOR SUSTAINABLE AGRICULTURE

MODIFY PHYSICAL PROPERTIES, DIFFUSION AND MASS FLOW

- Micronized & Nano scale nutrients

CHANGES IN NUTRIENT ACQUISITION & ROOT MORPHOLOGY

- Organic nutrients: Humates, Fulvates & Protein Hydrolysates
- Organic non-microbial biostimulants, seaweed extracts and other PGE's
- Plant Growth Promoting Microorganisms

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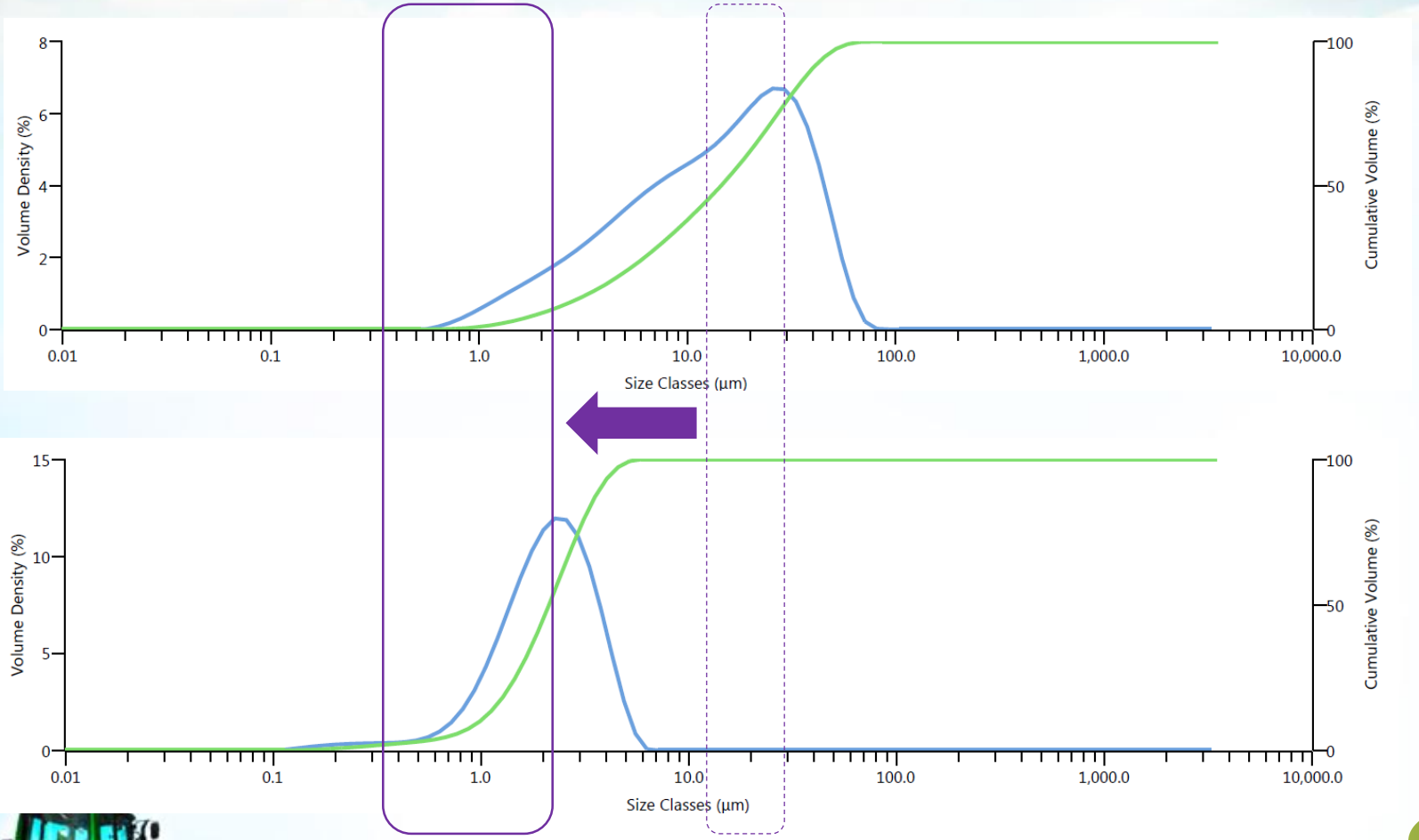
NUTRIENT AVAILABILITY: VALUE VS VOLUME

- SMALLER IS SOMETIMES BETTER: Nano Scale Powders



Zinc Carbonate

400nm 800nm 40µm 80µm

100X SIZE REDUCTION

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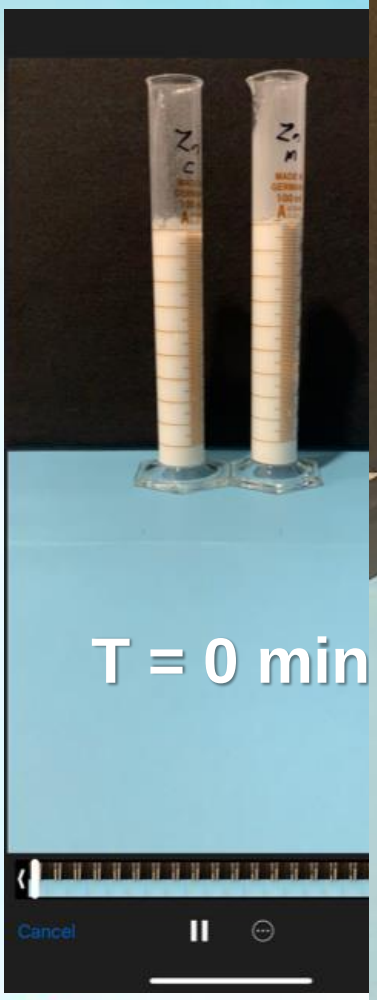
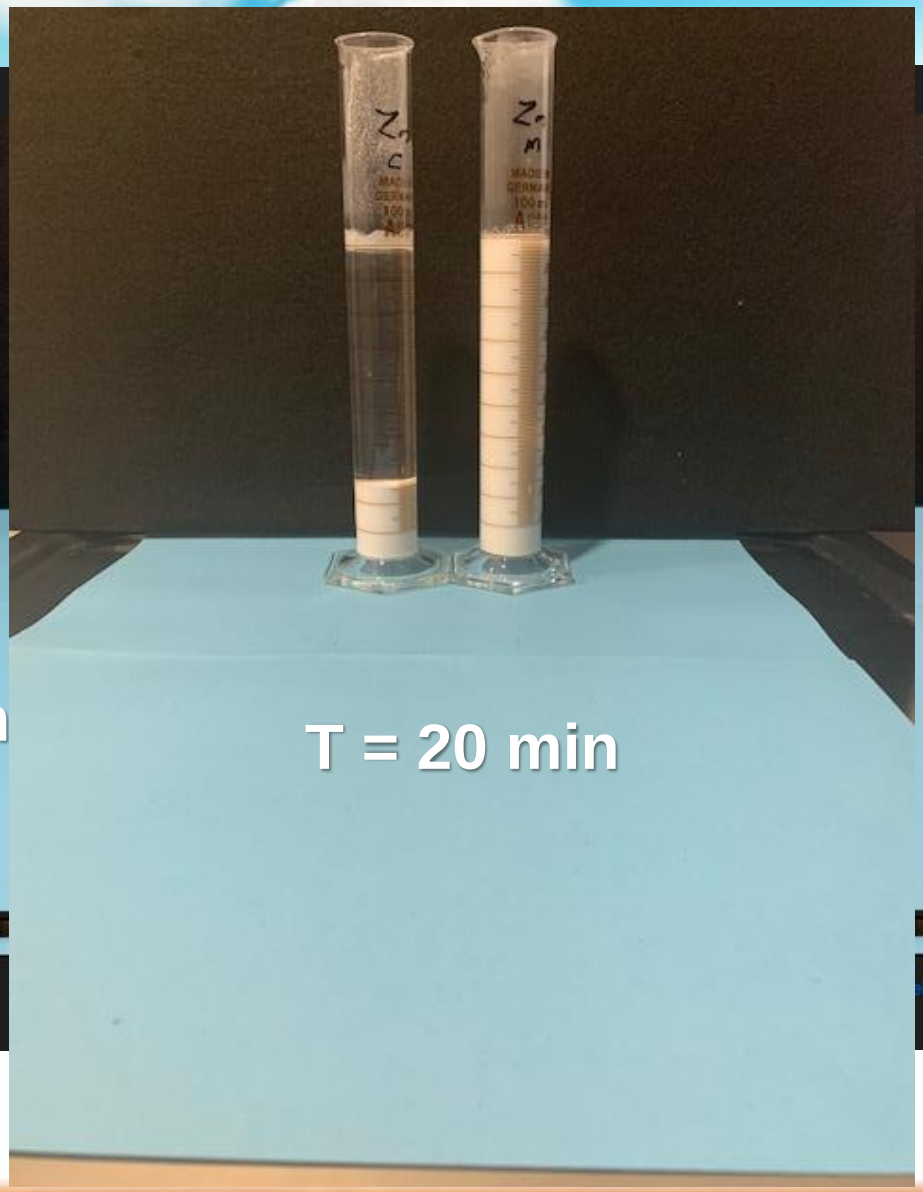
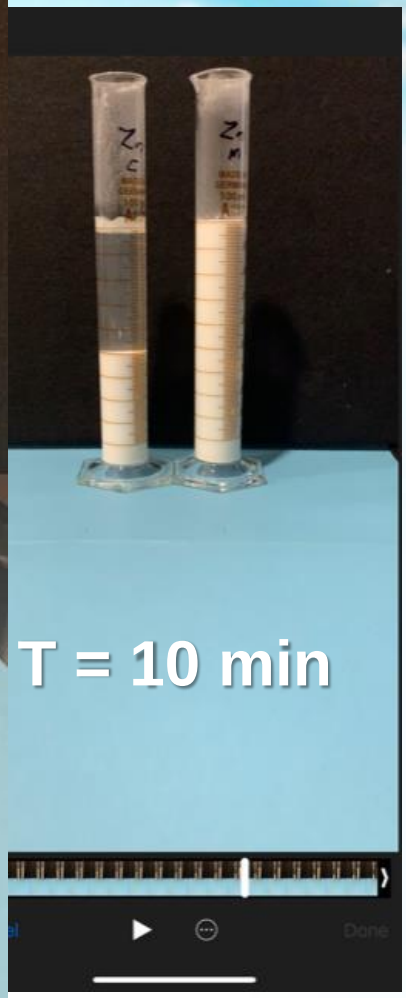
NANO SCALE POWDERS - ZINC

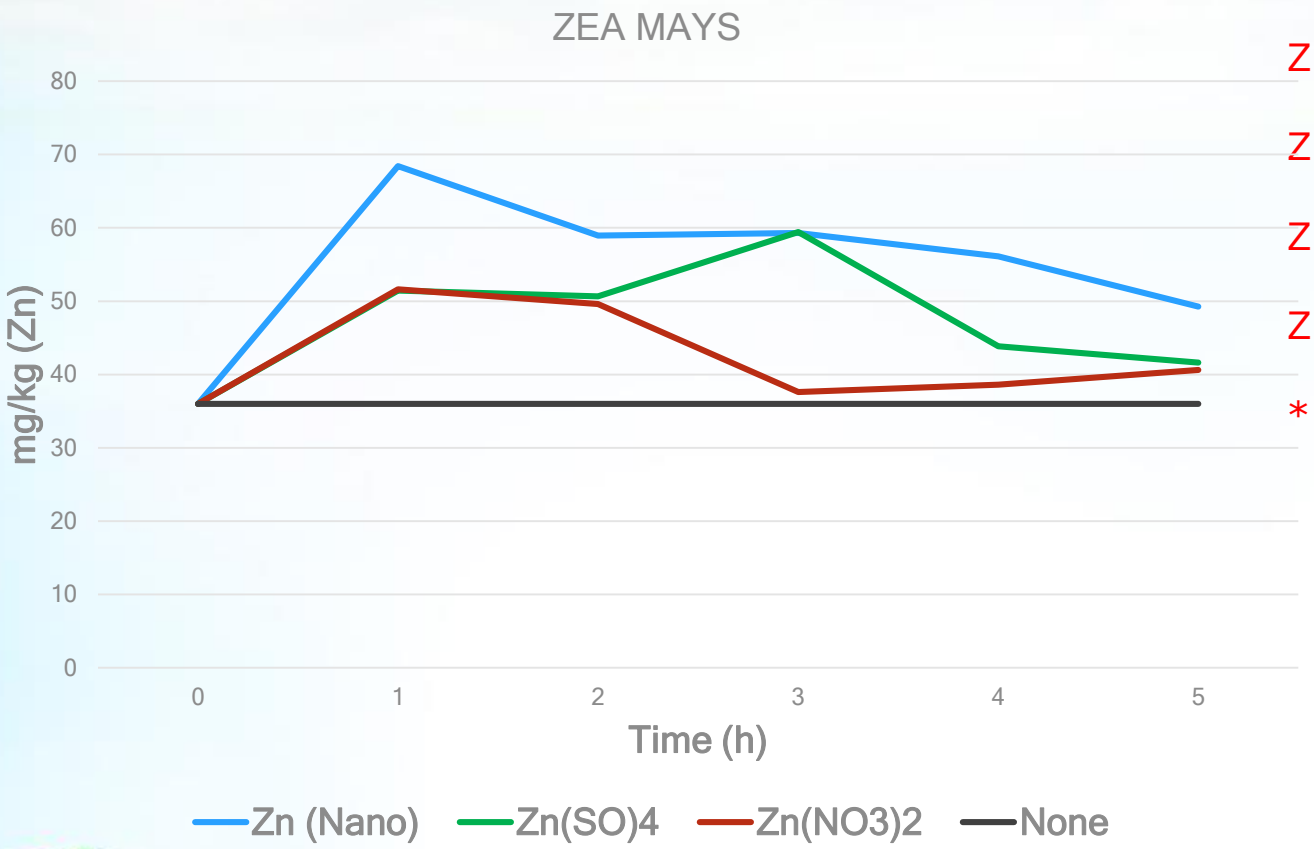






VALUE VS VOLUME PRINCIPLE

- **SMALLER IS SOMETIMES BETTER: Nano Scale Powder Nutrients**



$Zn = 360g/1000m^2$

Zn_N D90: 780nm

Zn_N vs $Zn(SO)_4$ > 18%*

Zn_N vs $Zn(NO_3)_2$ > 34%*

* = Over 5h period

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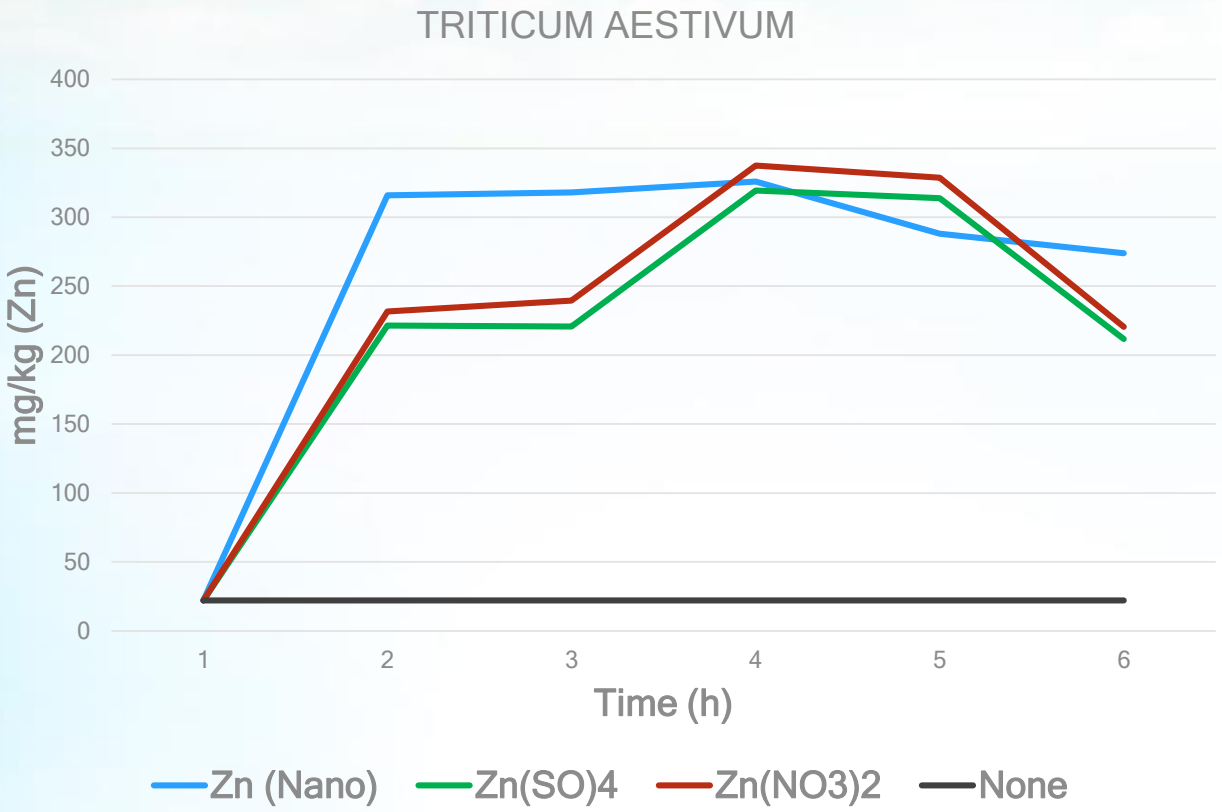
VALUE VS VOLUME PRINCIPLE

- **SMALLER IS SOMETIMES BETTER: Nano Scale Powder Nutrients**



$Zn = 720g/1000m^2$

Zn_N D_{90}: 780nm

Zn_N vs $Zn(SO)_4$ > 18%*

Zn_N vs $Zn(No_3)_2$ > 12%*

* = Over 5h period

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HUMIC SUBSTANCES

- Humic substances such as humic and fulvic acids are natural organic molecules originating from the biological and chemical transformations of dead organic matter (Nardi et al., 2007; Canellas et al., 2015).

- Humic substances have been perceived for long as primordial components of soil fertility and structure, acting on chemical, physical as well as biological properties of soils (du Jardin, 2015).

- The biostimulation action of HAs on soil nutrient availability and uptake has been attributed to several mechanisms affecting soil processes and plant physiology including:

  (i) improving soil structure,

  (ii) increasing cation exchange capacity and neutralizing soil pH,

  (iii) improving solubility of phosphorus by interfering with Ca-phosphate precipitation and also by increasing the availability of micronutrients by preventing leaching,

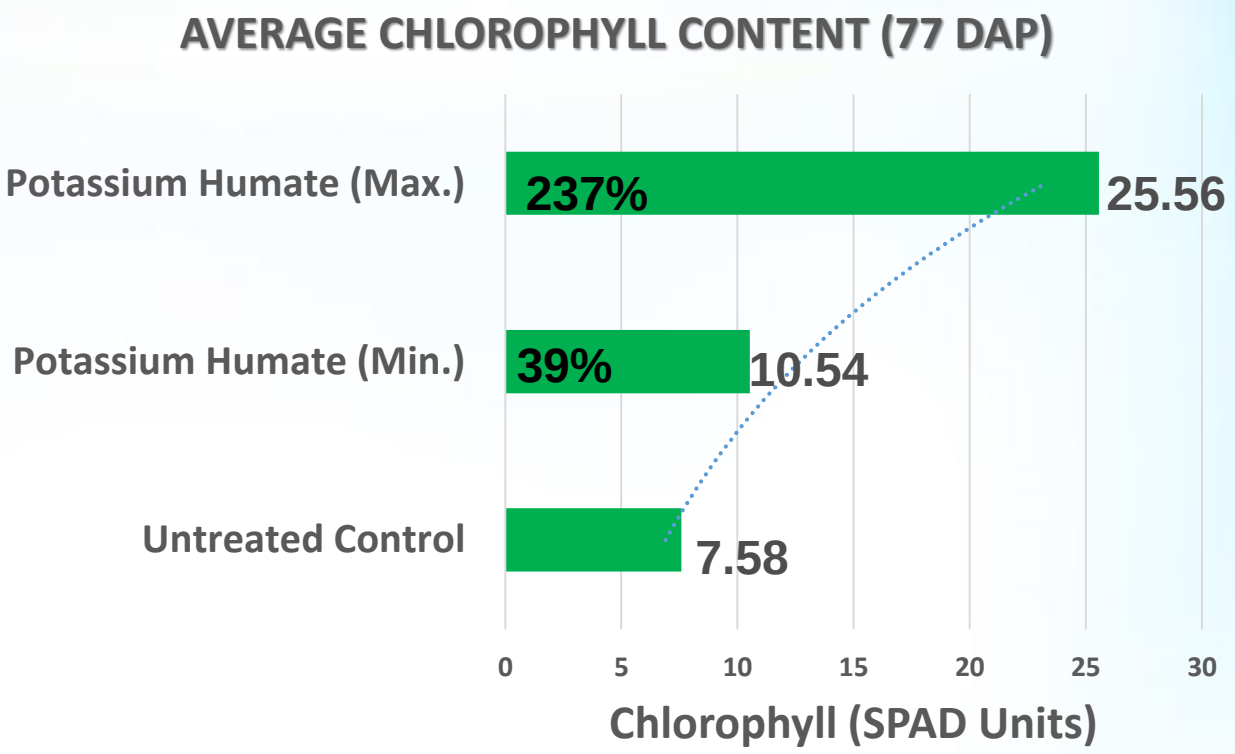
  (iv) improving lateral root induction and root hair growth due to the auxin-like activity, which triggers plasma membrane H^+-ATPase activity, and

  (v) stimulating nitrate assimilation through the upregulation of the target enzymes involved in this process

34 DAP: NETHOUSE TRIAL

HUMIC SUBSTANCES

77 DAP		
	UC	KH (avg)
N	3.6%	4.4%
P	0.4%	0.6%
K	2.8%	3.7%
Ca	0.6%	0.6%
Mg	0.2%	0.4%
Fe	98 mg/kg	84 mg/kg
Mn	48 mg/kg	59 mg/kg
Cu	8 mg/kg	11 mg/kg
Zn	37 mg/kg	52 mg/kg
B	8 mg/kg	8 mg/kg
Mo	3 mg/kg	3 mg/kg



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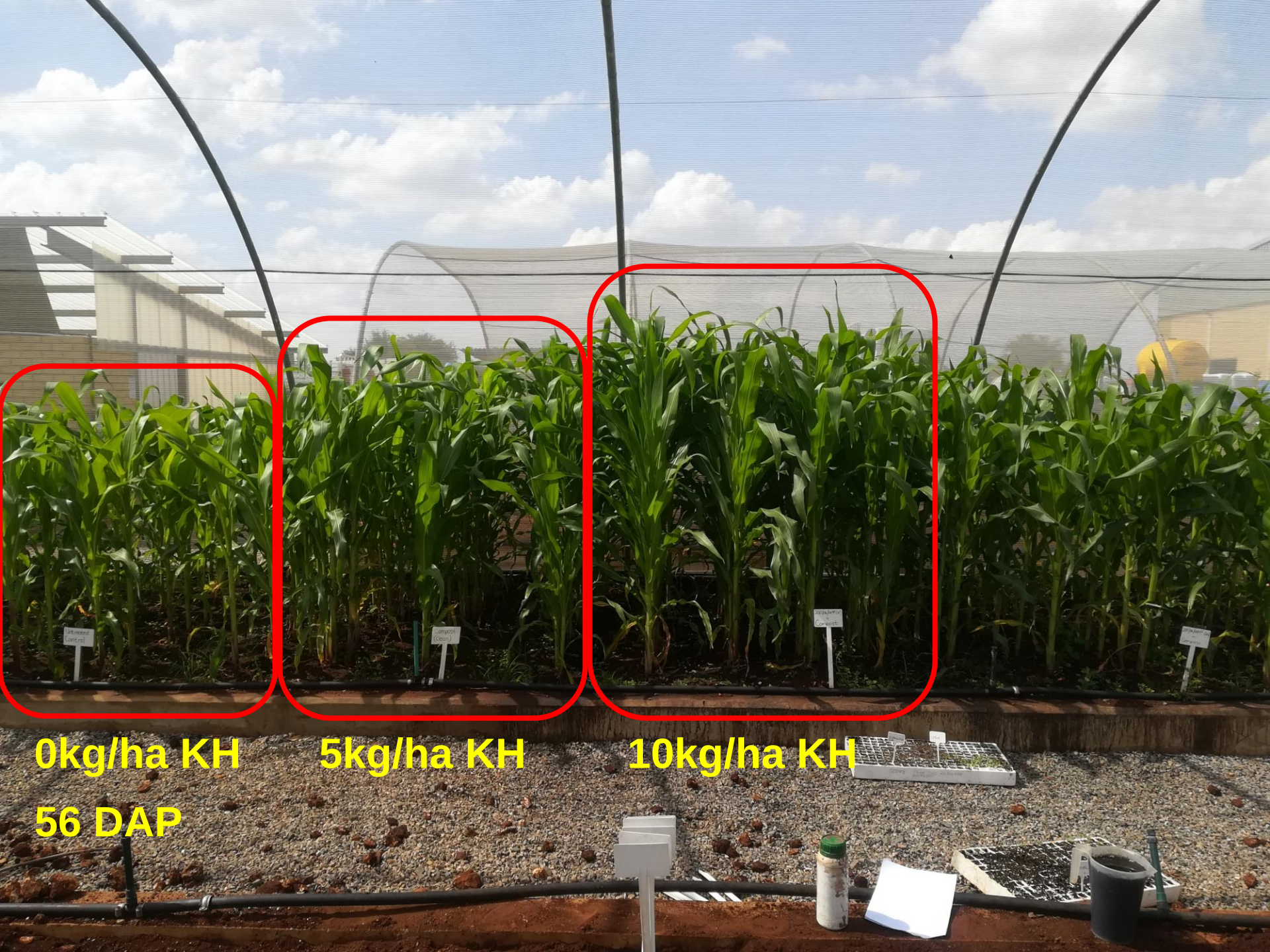
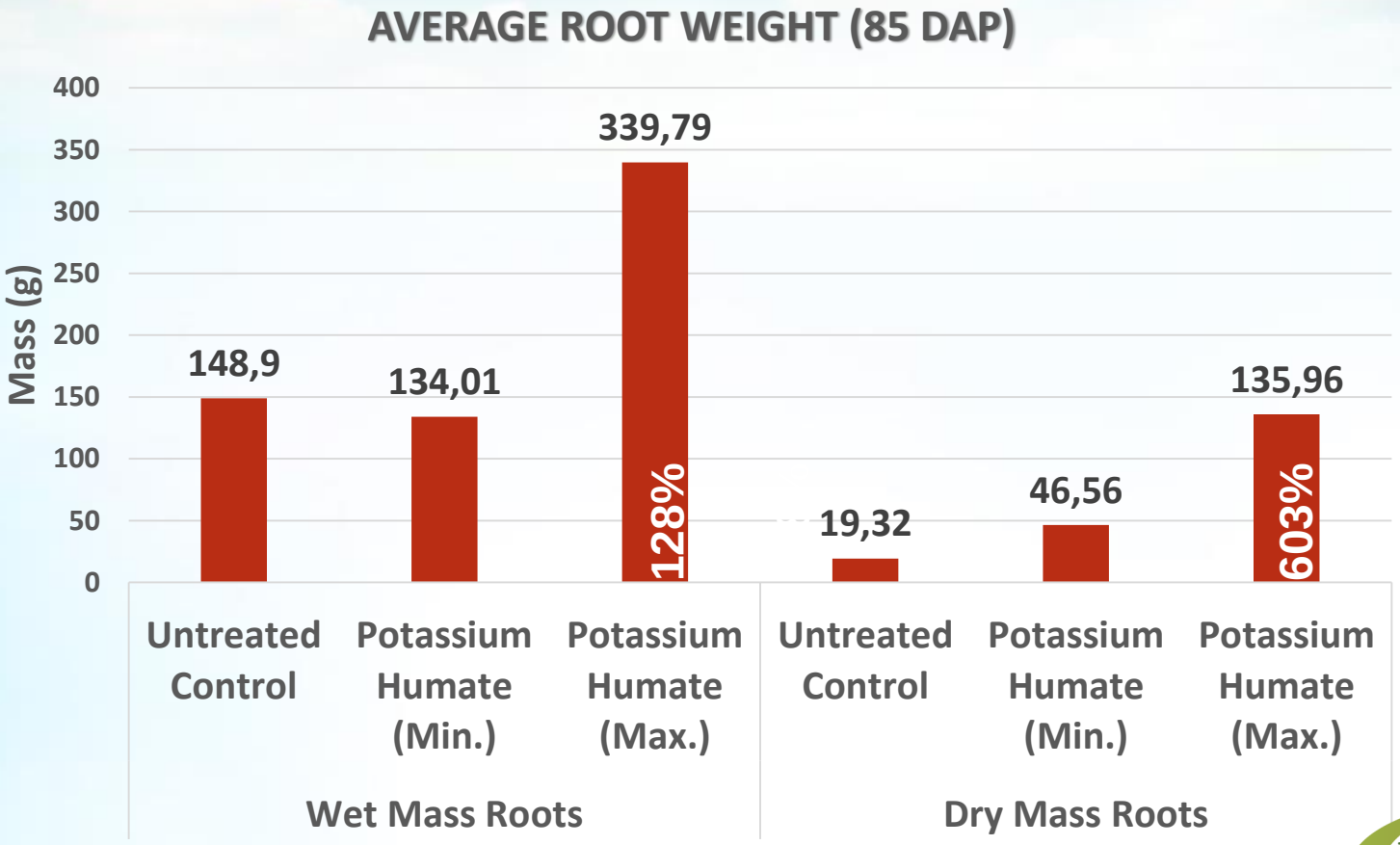

0kg/ha KH
5kg/ha KH
10kg/ha KH
56 DAP

HUMIC SUBSTANCES



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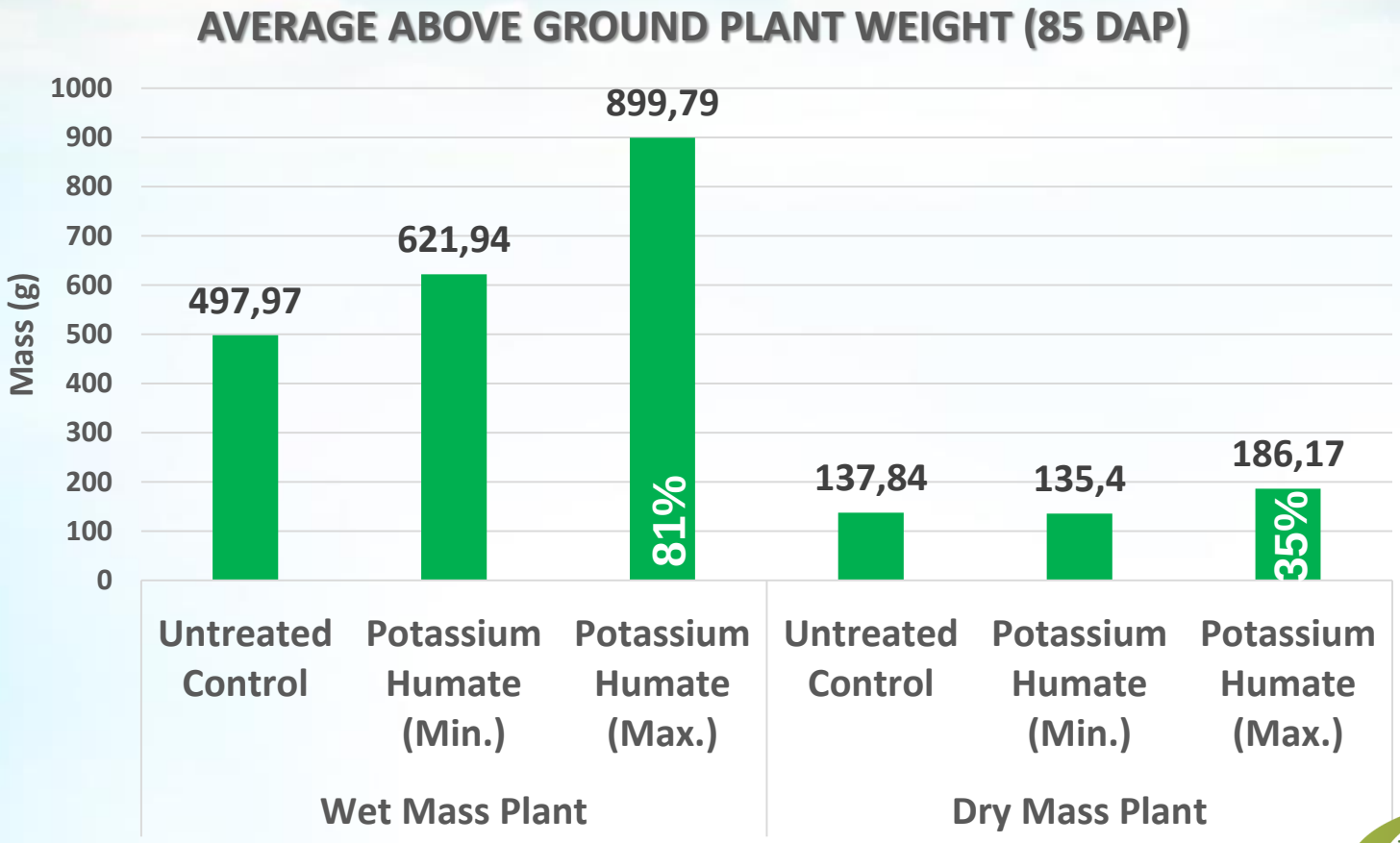
HUMIC SUBSTANCES



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RESPONSES VIA PLANT BIOSTIMULATION (PBs)

Biostimulators: "Materials of little or no fertilizer value that accelerate plant growth, usually when used at low concentrations" – Goatley & Schmidt, 1991

- PBs are defined through claimed agronomic effects, such as improvement of nutrient use efficiency, tolerance to abiotic stressors and crop quality.

- Based on the latest draft of the European Commission (2016), organic non-microbial PBs include natural substances such as humic acids (HA), protein hydrolysates (PH), and seaweed extracts (SWE). The SWE segment amounts to 37% of the total market according to the EU report.

- The next review section identifies several perspectives for future research to design and develop PBs with specific biostimulatory action to render agriculture more sustainable and resilient.

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POT TRIAL WHEAT 28 DAA

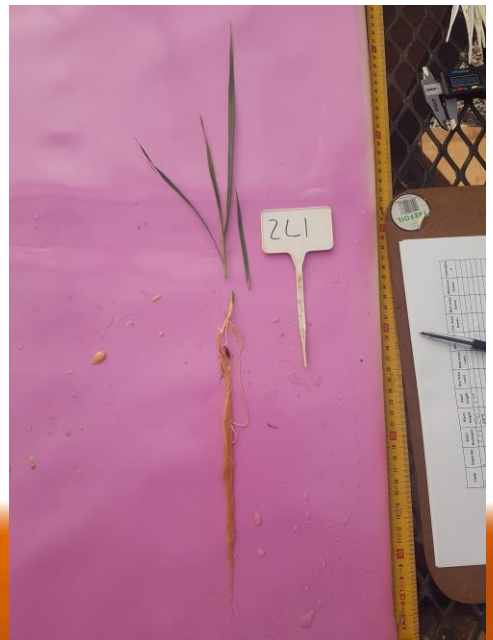
	Stem width (measured 10 mm above soil surface)	Max. length of plant (measured from 10 mm above soil surface)	Max. length of roots (measured from 10 mm below soil surface)	Dry mass of roots (measured after being cut 10 mm below soil surface, washed and then dried)	Dry mass of leaves (measured after being cut 10 mm above soil surface, washed and then dried)	Chlorophyll
1. Untreated control	1.44	155.75	233.50	0.13	0.04	37.40
2. Ecklonia maxima extract (EM)	2.04	231.25	395.00	0.18	0.10	45.91
3. Ascophyllum nodosum (AN)	2.02	226.50	331.88	0.20	0.10	41.35

% Increase / Decrease (EM)	42%	48%	69%	36%	137%	23%
% Increase / Decrease (AN)	40%	45%	42%	52%	120%	11%

Average Increase in growth (EM)	53%
Average Increase in growth (AN)	42%

Average Increase in mass (EM)	86%
Average Increase in mass (AN)	86%

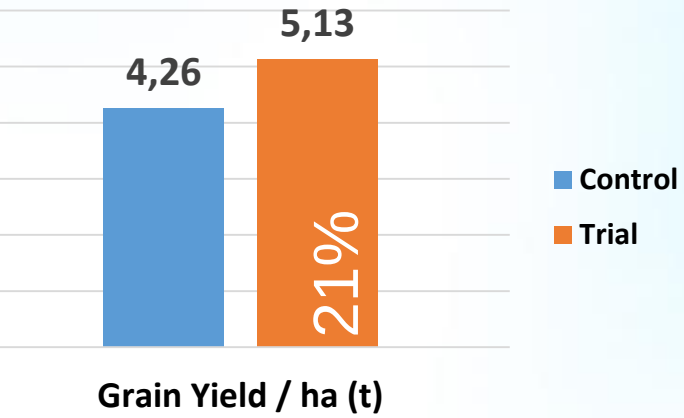
Average Increase in Chlorophyll (EM)	23%
Average Increase in Chlorophyll (AN)	11%



ROOT BIOSTIMULATION

FIELD TRIAL

50ml/ha: Ascophyllum nodosum extract +
1g/L Auxin



POT TRIAL MAIZE 28 DAA

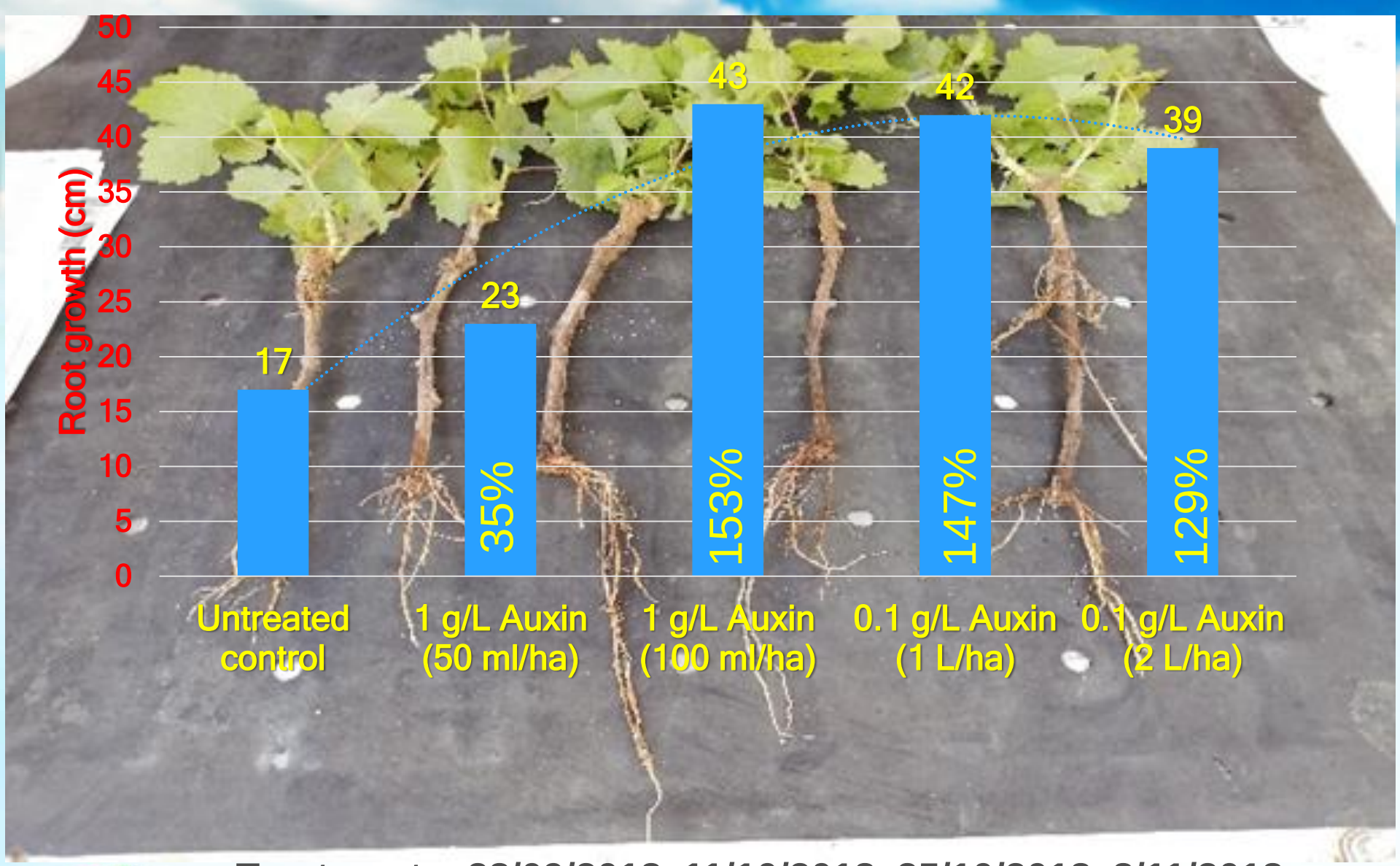
	Stem width (measured 10 mm above soil surface)	Max. length of plant (measured from 10 mm above soil surface)	Max. length of roots (measured from 10 mm below soil surface)	Dry mass of roots (measured after being cut 10 mm below soil surface, washed and then dried)	Dry mass of leaves (measured after being cut 10 mm above soil surface, washed and then dried)	Chlorophyll
1. Untreated control	5.14	266.42	461.67	5.72	2.43	16.2
2. Ecklonia maxima extract (EM)	9.90	338.45	489.75	8.89	4.51	17.4
3. Ascophyllum nodosum (AN)	9.63	327.30	487.42	8.94	4.25	17.1

% Increase / Decrease (EM)	92%	27%	6%	55%	86%	7.4%
% Increase / Decrease (AN)	87%	23%	5%	56%	75%	5.6%

Average Increase in growth (EM)	42%
Average Increase in growth (AN)	38%

Average Increase in mass (EM)	71%
Average Increase in mass (AN)	66%

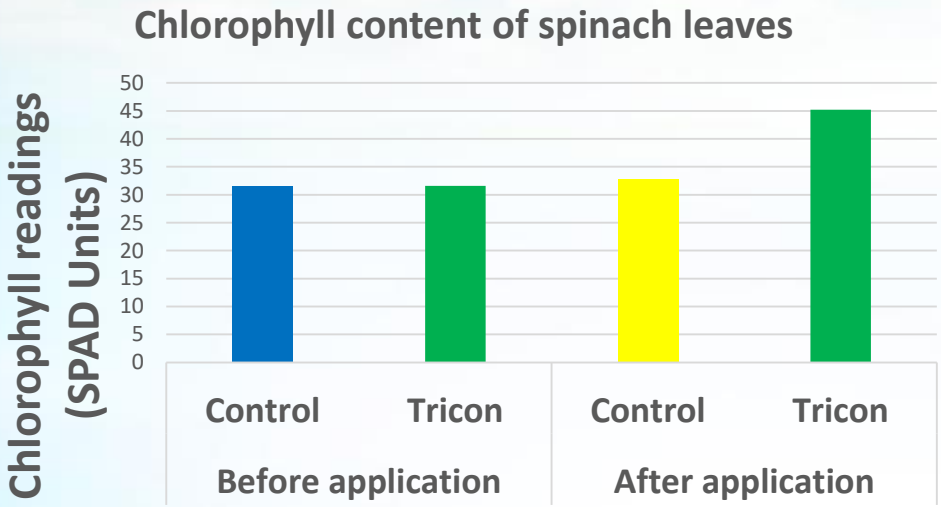
Average Increase in Chlorophyll (EM)	7%
Average Increase in Chlorophyll (AN)	6%



Treatments: 28/09/2018, 11/10/2018, 25/10/2018, 8/11/2018
Termination: 12/11/2018

FOLIAR BIOSTIMULATION

- Stimulating photosynthesis – Triacontanol (Tri)



Before application 0 DAA		After application 14 DAA	
Control	Tri	Control	Tri
31.6	31.6	32.9	45.2

37%

GIVING GREEN FUEL TO THE PLANT ENGINE

SUMMARY

- This subject matter is so wide a whole conference can be spent on the topic of NUE. This was not even the tip of the iceberg
- Conditions for Agriculture is not going to improve
- Efficient fertilizer use is essential for long term sustainability in agriculture
- The use of modern technological advances will increase NUE and NUcE
- Farmers should focus more on conservation farming
- Protect our soils, our water sources and our beneficial microbes.

NUTRIENT STEWARDSHIP FRAMEWORK, THE FOUR RIGHTS (4Rs)

Application of the **RIGHT NUTRIENT**, at the **RIGHT RATE**, in the **RIGHT PLACE**, at the **RIGHT TIME**

THANK YOU

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