Soil Biorenovation of heavily depleted agricultural soils:

Benefits of using Efficient Microbes to improve soil health & fertility in heavily depleted agricultural soils in Belize

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General Manager

BELIZE


Where are we?
Belize is considered to be part of both Central America and The Caribbean.
How Big is Belize?
Skip the Crowds!
Mexico
Belize
Guatemala
Honduras
Nicaragua
Costa Rica
Panama
Cuba
Jamaica
Cayman Islands
La Habana
Santa Clara
Dallas
Austin
Houston
San Antonio
Tucson
Phoenix
Tijuana
Texas

Soil Characteristics

South
(Citrus, Bananas, Cacao)

- Inceptisols
  - **Clay above 45%** in the first horizon
  - low in depth
  - pH moderate 5
  - **OM% below 3**
  - K - low, Ca & Mg - moderate, N- low, P low
- Ultisols
  - **High clay** content
  - pH below 4
  - **OM% below 3**
  - K - low, N- low, P low, Fe-high

North
(Sugarcane, Grains Vegetables)

- Inceptisols
  - **Clay above 45%** in the first horizon
  - low in depth
  - pH above 7
  - **OM% below 4**
  - K - low, Ca - high, N- low, P low
- Vertisols
  - **Clay above 45%** in the first horizon
  - low in depth
  - pH above 7
  - **OM% below 3**
  - K - low, Ca - high, N- low, P low
  - Poorly drained
  - High water holding capacity

The Challenge in Agriculture

- to produce more food on a declining land area, with soils and ecosystems that are continually being degraded — all while using less water, energy and natural resources under difficult economic circumstances.

Source: Angela Lovel in https://www.no-tillfarmer.com/articles/8937

Our Goal

* to accelerate soil health and productivity while helping growers to stay profitable.

3 Simple Principles to build soil fertility, make them more healthier & productive

Problem:

- Adoptation
- Establishment Time
- Economic Cost

1. **disturb the soil as little as possible**
2. **maintain some sort of ground cover**
3. **have a diverse mix of plants &/or animals where possible**

Solution

* add biologicals & carbon source

EM®
Effective Microorganisms

An Economic & Ecological Alternative for Soil Biological Renovation

AUTHORIZED MANUFACTURER

Why?

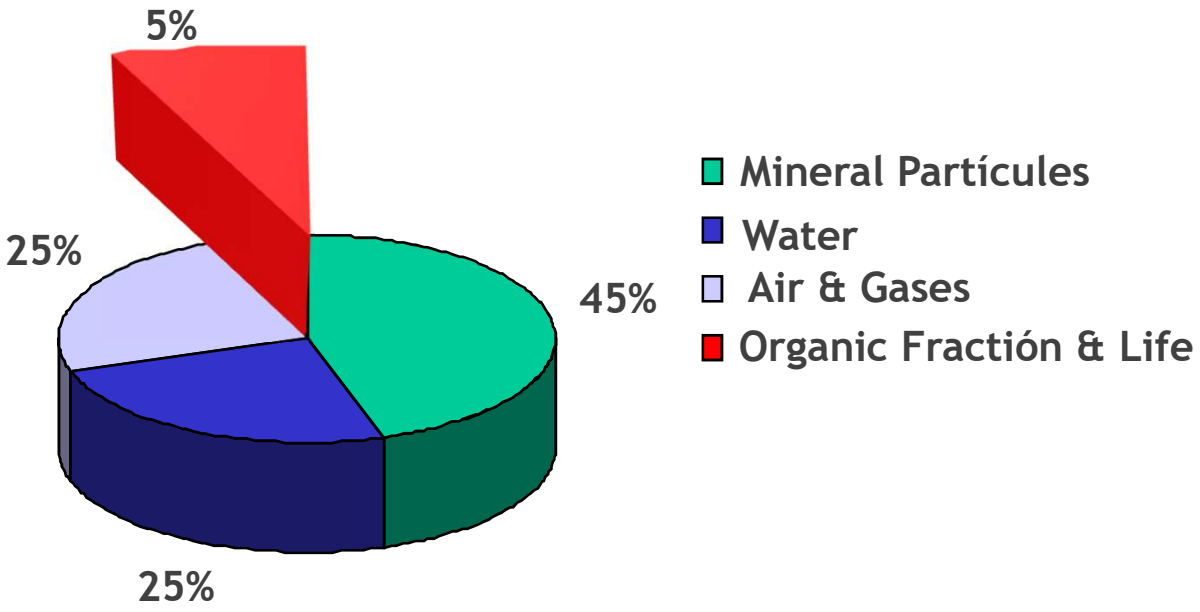
What is Soil?

Mechanical Support of plants

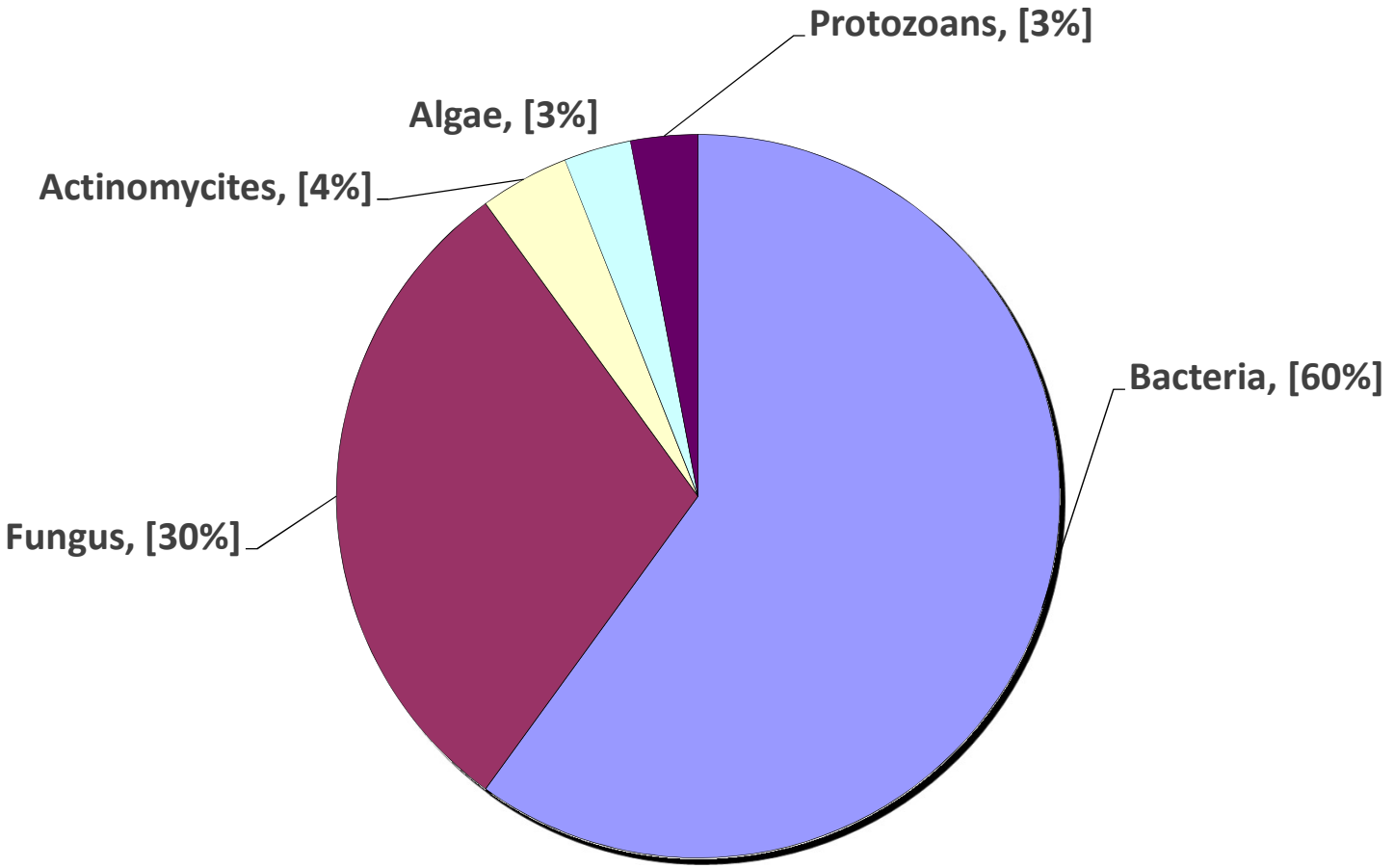
Large quantities of **Organic substances**

Site of one of the most **Dynamic biological interaction**

Soil is the Basis of Sustainability



Organisms Present in Soil



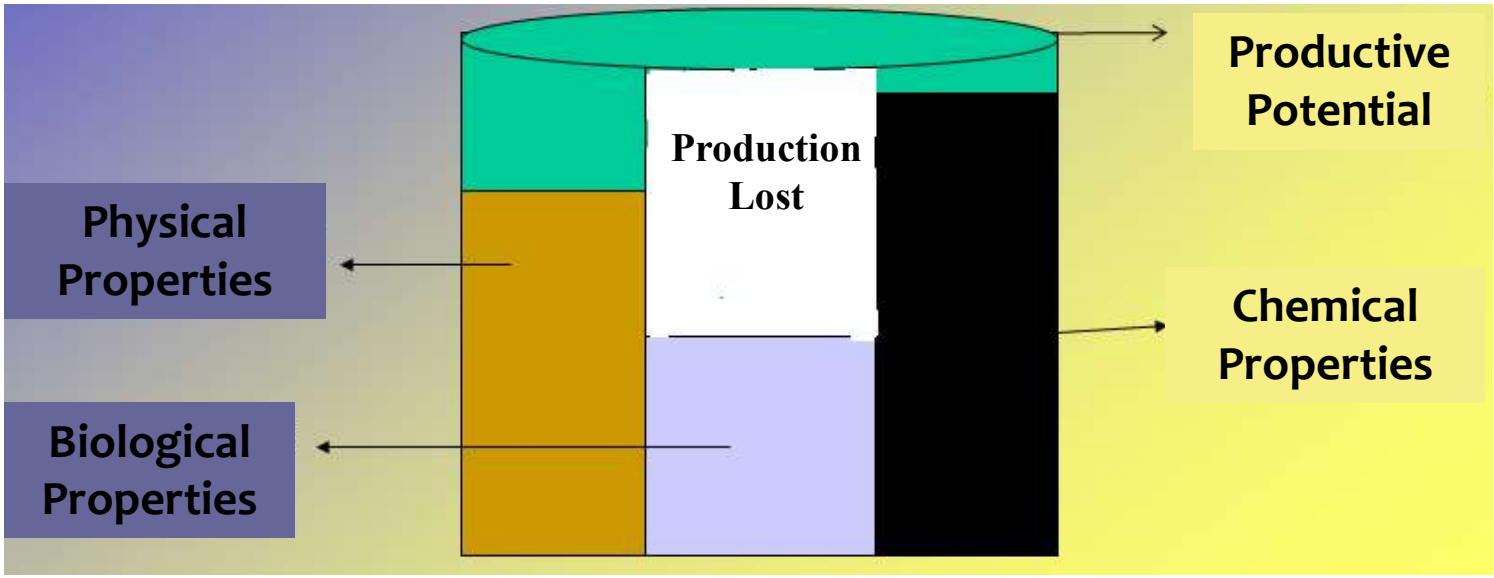
MICROBIOLOGICAL CLASSIFICATION OF SOILS

SOIL TYPE	MICROORGANISMS TYPE	TYPE OF AGRICULTURE
DISEASE INDUCERS	*Fusarium sp.* *Phytium sp.* *Botritys sp.*	Modern
DISEASE SUPPRESSORS	*Penicillium sp.* *Aspergillus sp.* *Trichoderma sp.*	Ecological
ZIMOGENOS	*Lactobacillus sp.* *Sacharomyces sp.*	Organic
NUTRIENTE SINTHESIZERS	*Rhizobium sp.* *Azospirillum sp.* *Azotobacter sp.*	Natural

EM
Effective Microorganisms

SOIL FERTILITY

The level of agricultural production cannot be more than what is permited by the most limiting and essential factors of plant growth.



Microorgansims & Soil Carbon: Why?

- **Direct correlation between plant growth / organic matter**
  - **Both** higher in microbial inoculated soils.
- **Organic matter: energy resource for microbes in the soil**
  - **The Plant system will transfer that energy to the soil in order to naturally increase microbial population**
  - **Microbes** are essential for healthy soil & increase soil productivity.

Low carbon system: plant growth

photosynthetic energy captured by the plant that would go into growth

Microorgansims & Soil Carbon: Why?

* **Plants grow better in microbial inoculated soil**
  - Fungal-to-bacterial ratio higher
* ⇧fungal ratio + ⇧carbon content = **Increase energy flow into the plant**

INCREASE PRODUCTION

Important Functions of Microbes in the soil

Mineralization of Organic Matter

Mineral Solubilization

Nitrogen Fixation

Chelation of Minerals

Root Growth & Morphology

Absorption & translocation of minerals

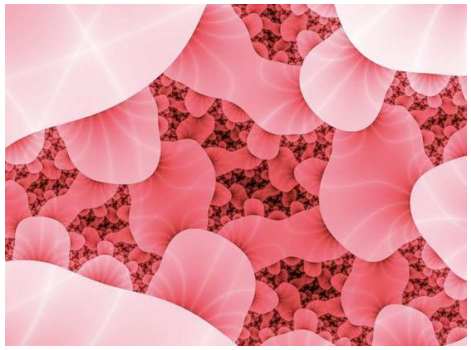
Enzymes & Vitamin Production

Production of phytohormones

Soil Agregation & Stability

What is in EM Technology™?

It consists of 3 groups of well known class of microorganisms that synergistically work with each other to create an antioxidative environment within the degraded soil environment where they are placed.

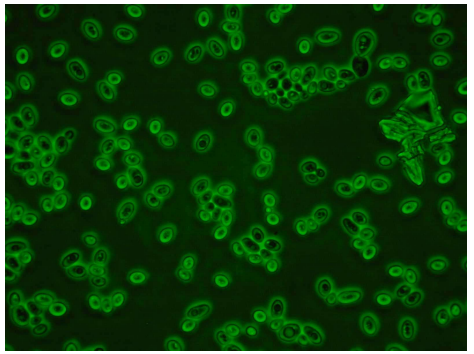


Photosynthetic

Photosyntheic Bacteria
(soil, sea, water)

Lactobacillus

Lactic Acid Bacteria
(yogurt, cheese, etc)



Saccharomyces

Fermenting Yeast
(bread, wines, beers)

Not noxious, not pathogenic, not genetically modified, not chemically synthetisize

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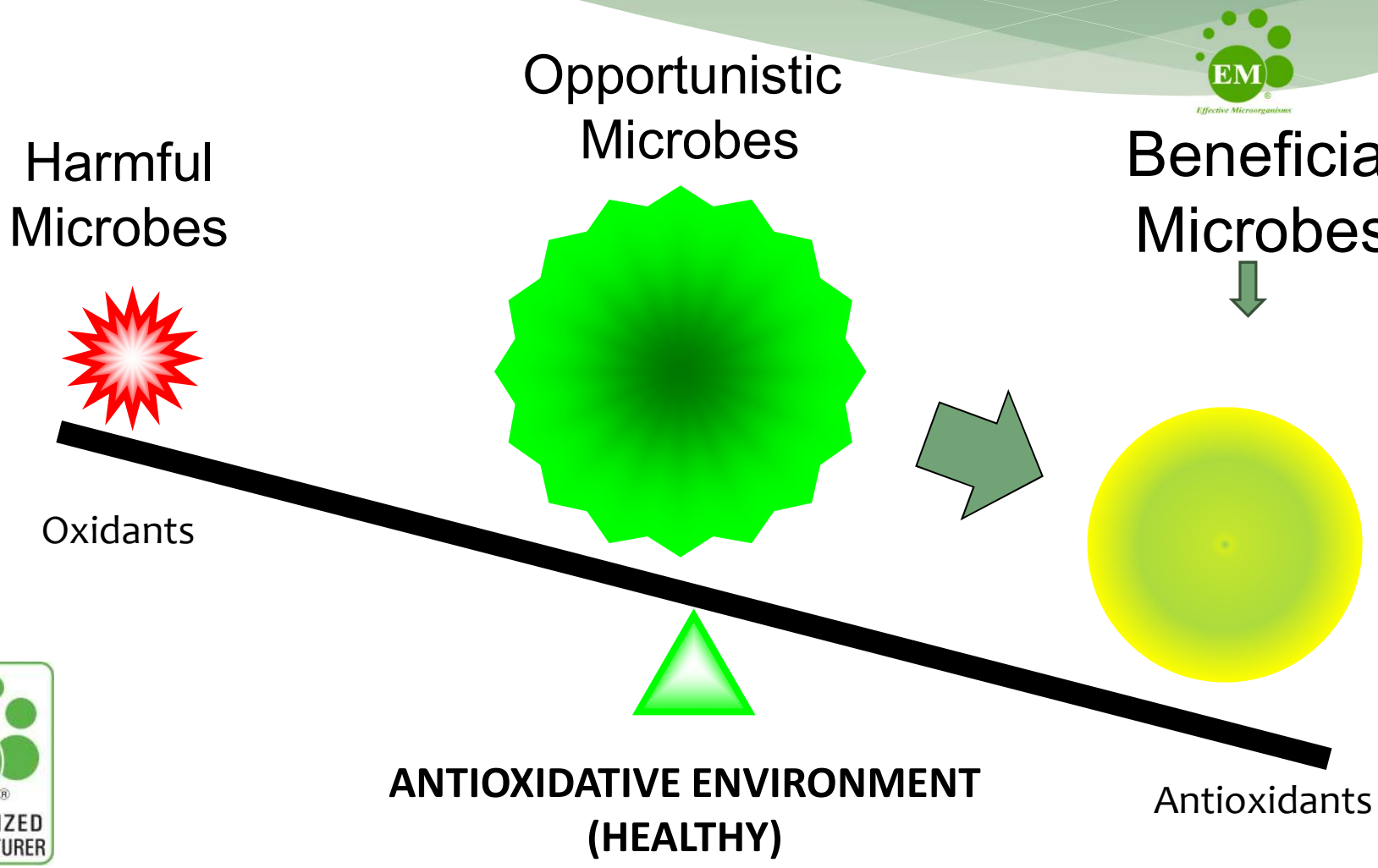
A Biorenovative Transformation using EM Technology™



Function: Acts Specifically on Organic Matter

- Accelerates Decomposition: Separation of organic compounds (proteins, sugars, fat, fibers, etc.).
- Acts in two principal ways:

I) Competitive Exclusion of pathogenic microrganisms.
II) Production of beneficial substances:

:: Vitamins :: Antioxidants
:: Aminoacids :: Enzymes

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Soil Biorenovation using EM Technology™ in young citrus groves on Calcitic & Acidic Soils in Belize

(EM™ with Humic Acid Fertilizer Programme)

Ing. Lestor Cabral (CREI)
Ing. Yanis Murcia (CREI)
*MAgr.; Ing Agr. William Usher (BAEL)

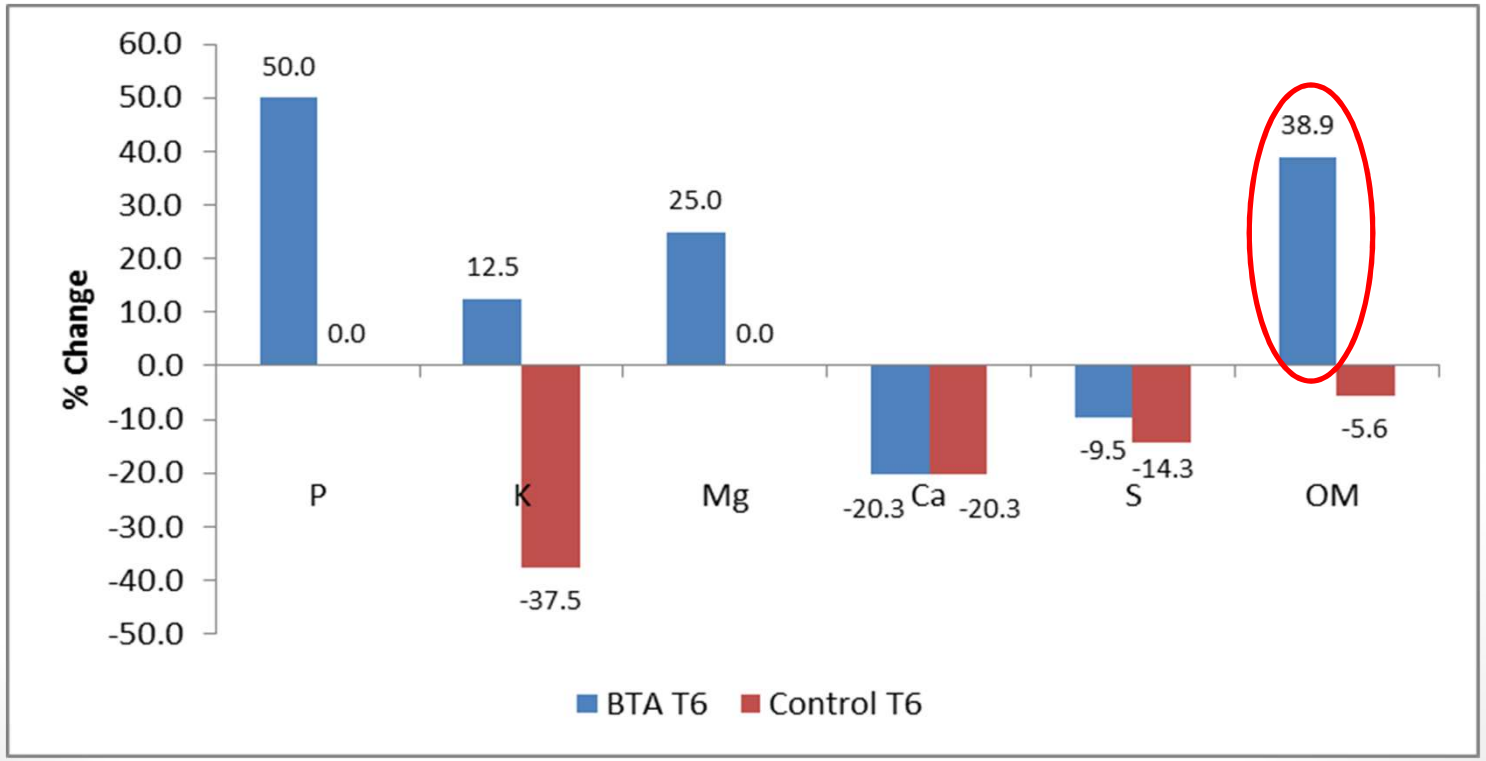
Nutritional treatment #1: Drench application in Calcitic & Acidic Soils

	Calcitic:	Acidic
Product	ECO HUM RX + , EM Agriculture	ECO HUM RX +, EM Agriculture
Acreage/trees	1 acre (100 trees)	1 acre (100 trees)
Type a soil	Alkaline soils, pH: 8	Acid Soils, pH: 4.9
Evaluation period	6 months	6 months
Dose per acre	2.5 L/acre + 20 L acre	2.5 L/Acre + 20L/acre
Frequency	Two applications in total 1st application September last week 2nd application March,2014	Two applications in total 1st application September last week 2nd application March, 2014
Method	**Drench to roots**	**Drench to roots**

Results – Soil Analysis (Calcitic Soils)

Macro Nutrients

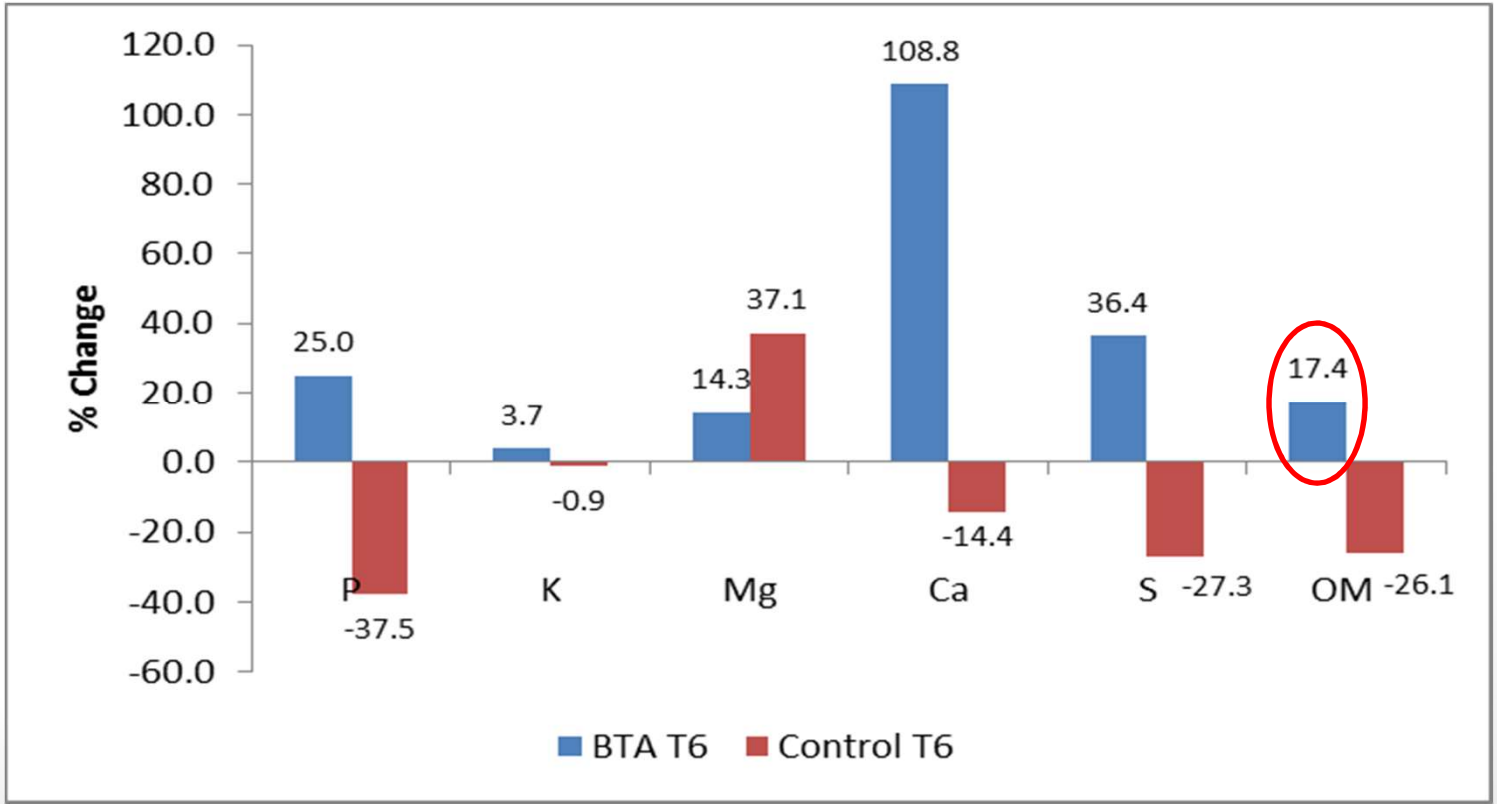
Time	Content (%)							
	P	K	Mg	Ca	S	pH	OM (%)	C.E.C. (%)
T0	10	160	96	7532	21	8	1.8	38.8
With EM™ (BTA T6)	15	180	120	6000	19	8	2.5	33.1
No EM™ (Control T6)	10	100	96	6000	18	8	1.7	37.1
Reference Norm (S)	26-42	150-250	60-180	1000-2000	8.00-12.00	5.5-6.5	2.3-3.7	Clay soils



Results – Soil Analysis (Acidic Soils)

Macro Nutrients

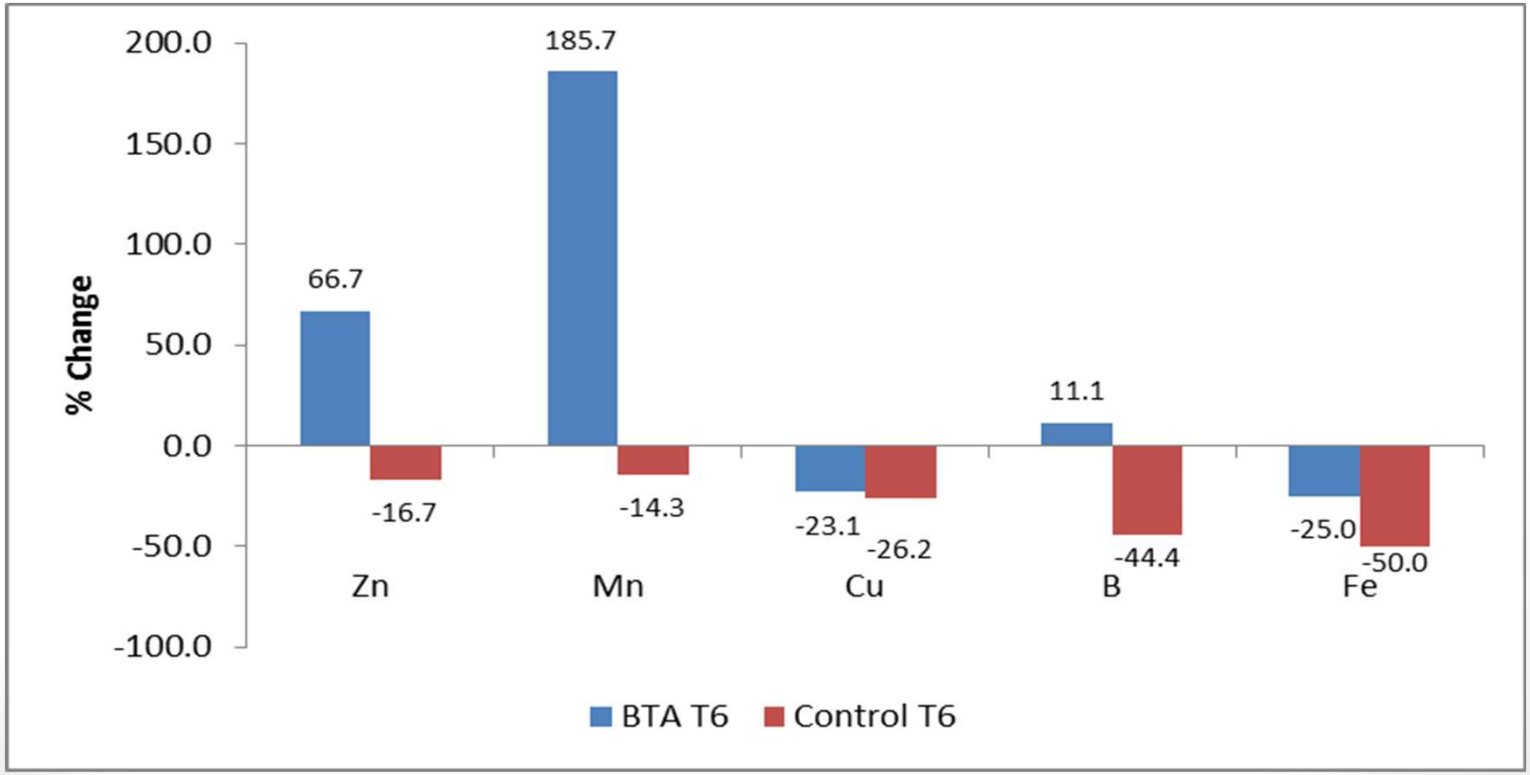
	Nutrient Content (%)							
	P	K	Mg	Ca	S	pH	OM (%)	C.E.C. (%)
T0	16	214	70	479	11	5.4	2.3	5
With EM™ (BTA T6)	20	222	80	1000	15	5.8	2.7	5.7
No EM™ (Control T6)	10	212	96	410	8	5.1	1.7	5
Reference Norm (S)	26-42	150-250	60-180	1000-2000	8-12	5.5-6.5	2.3-3.7	sandy soil



Results – Soil Analysis (Calcitic)

Micro Nutrients

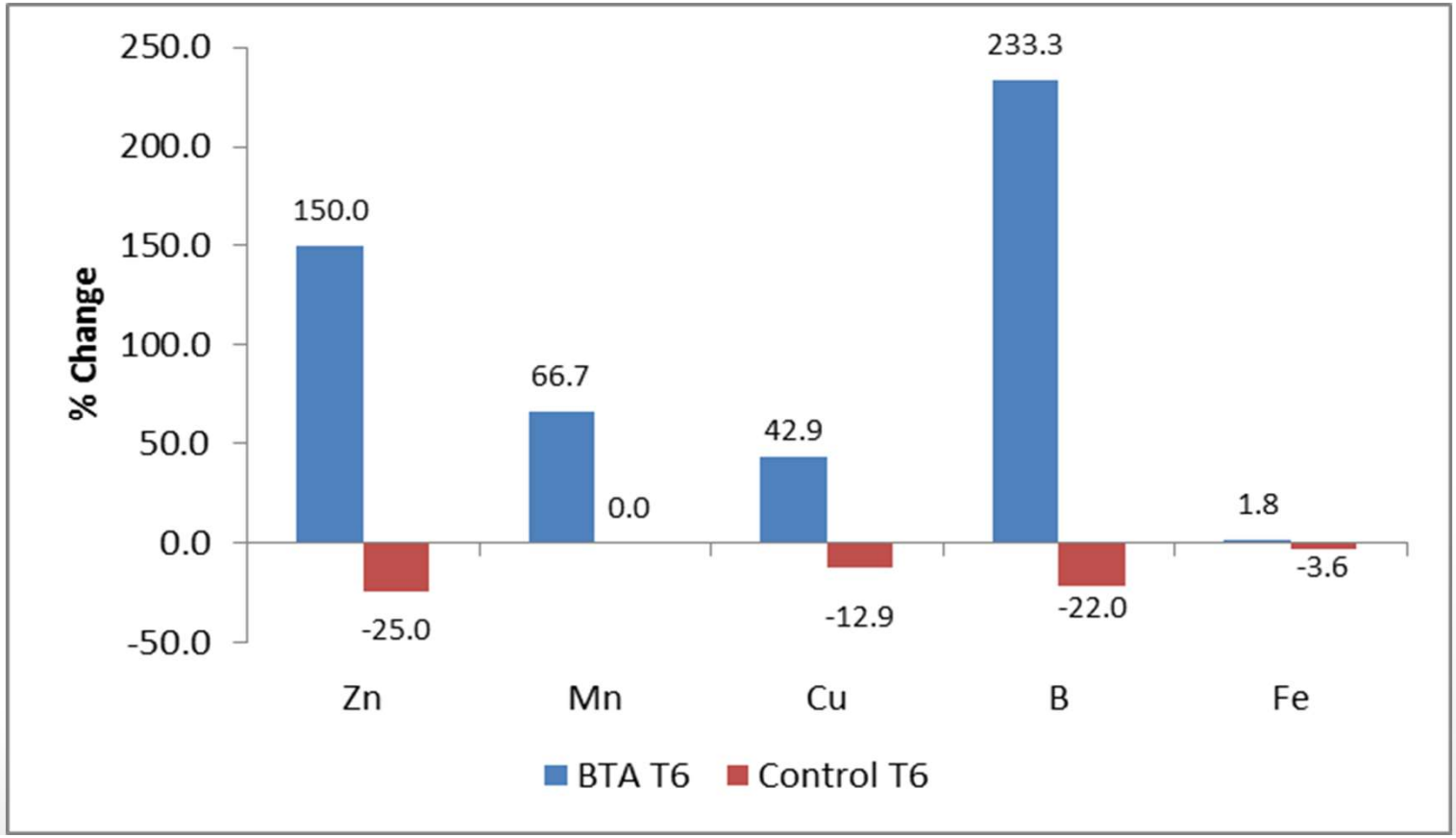
Time	Contents (ppm)				
	Zn	Mn	Cu	B	Fe
T0	1.2	7	1.3	0.9	20
With EM™ (BTA T6)	2	20	1	1	15
No EM™ (Control T6)	1	6	0.96	0.5	10
Reference Norm (S)	3.0-4.9	15-29	0.6 -1.2	0.6 -1.2	12 -24



Results – Soil Analysis (Acidic)

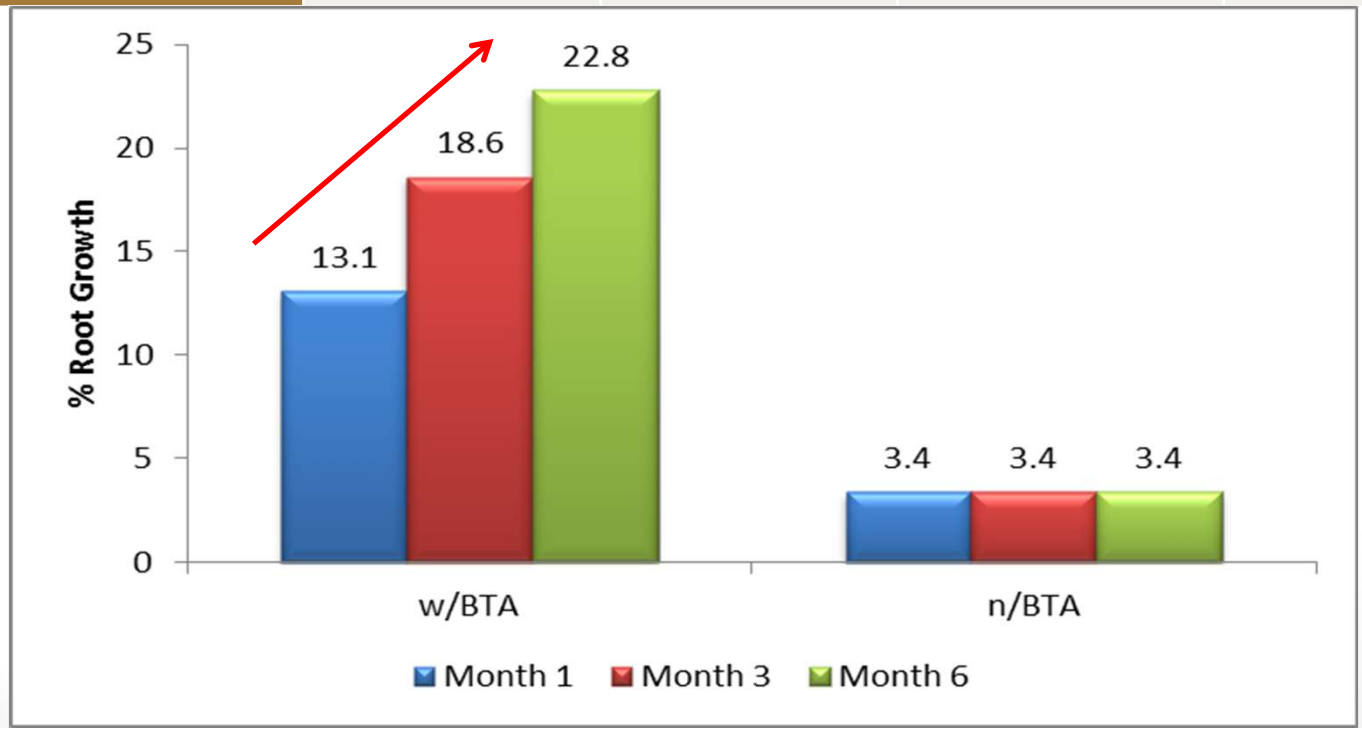
Micro Nutrients

Time	Nutrient Content (ppm)				
	Zn	Mn	Cu	B	Fe
T0	0.4	6	0.7	0.3	55
With EM™ (BTA T6)	1	10	1	1	56
No EM™ (Control T6)	0.3	6	0.61	0.234	53
Reference Norm (S)	3.0-4.9	15-29	0.6 -1.2	0.6 -1.2	12 -24



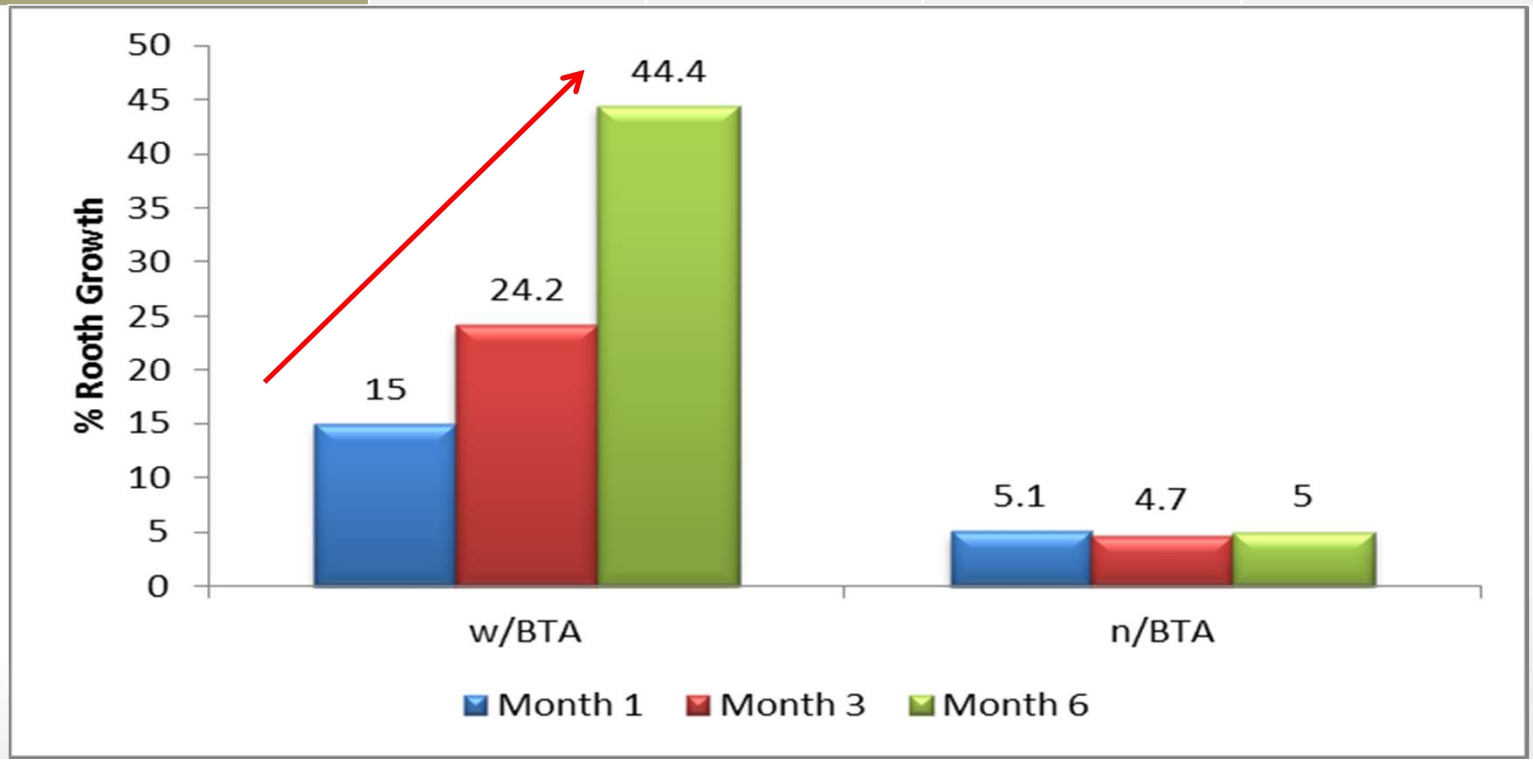
Results – Root Growth Analysis (Farm 1 -Calcitic)

Time	Root Growth on Farm 1			
	With EM™ Technology		Without EM™ Technology	
	Weight (g)	% weight change	Weight (g)	% weight change
Month 0	193		192	
Month 1	222	13.1	199	3.4
Month 3	237	18.6	198.8	3.4
Month 6	250	22.8	198.8	3.4



Results – Root Growth Analysis (Farm 2 - Acidic)

Time	Root Growth on Farm 2			
	With EM™ Technology		Without EM™ Technology	
	Weight (g)	% weight change	Weight (g)	% weight change
Month 0	190		189	
Month 1	223	15.0	199	5.1
Month 3	251	24.2	198.4	4.7
Month 6	342	44.4	199	5.0



Effect of Soil Biorenovation on Sugarcane Production Parameters in Belize

Use of EM Technology ™

MSc. Lorenzo Quiroz (BSI)
Ing Agr. Lenardo Pech (BSCFA)
Ing Agr. Marcus Osorio (SIRDI)
* Ing Agr. William Usher (BAEL)

BSI Trial:

Objectives/Methodology

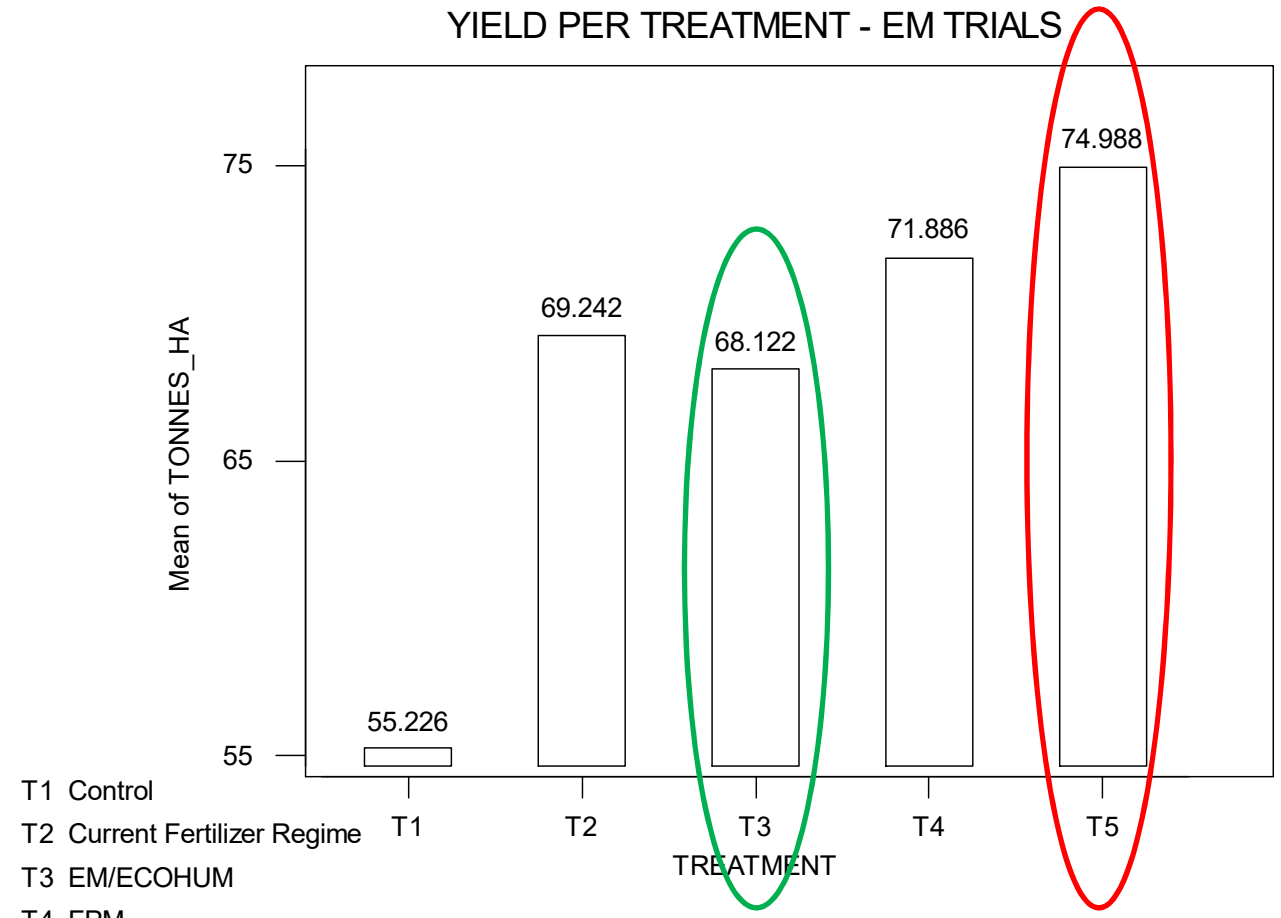
Fair Trade Obligation:
3.2.23 NEW 2019*
Improve Soil Fertility

- Increase productive capacity of the sugarcane crop within the areas treated with the combination of Effective Microbes (EM™) and Eco Hum™ (Humic Acids) soil applied root drench fertilizers.

T1 Control - No fertilizer or soil amendment done
T2 CFR - (Current Fertilizer Regime) - 660 lbs./ha of 22 - 10.5 - 22 + Cu + Zn at 1% at planting and 110 lbs/ha of 46 - 0 - 0 as side dressing 6 weeks later
T3 BAEL Technology - (EM + ECOHUM*)
T4 Filter Press Mud (FPM) at approximately 100 tonnes per ha. immediately before planting
T5 BAEL + FPM

Industry Trial Results: Increase Production with EM™ + Filterpress Mud

(Organic Amendment)



Field Results: Increase Vigor

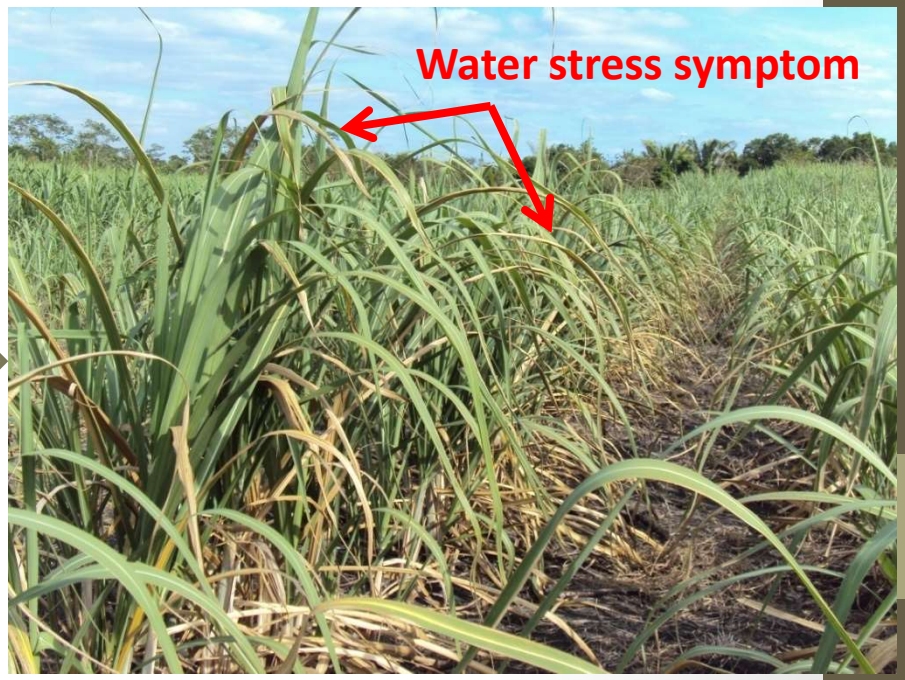
Increased vigor and stalk thickness with the use of EM Technology™ (SIRDI, 2012).

Increased number of shoots using EM Technology™

Field Results: Less Water Stress

With EM™

No EM™



Post Harvest Trash Management

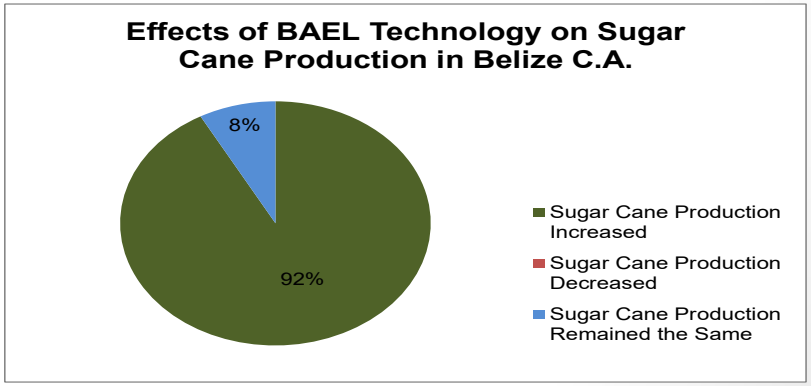
- 20L EM™/acre
- Reduction in weeds
- Improve soil % OM

Field Results: Farmers' Review

- Farmers attests to production hike from 25 tons/acre to 40 tons/acre.
- Farmer observed improved soil macro & micro-fauna

Filiberto Cob in his cane field in San Pedro, Corozal, Belize, C.A. (BAEL, 2013).

Mycelium growth in Cane Field where EM was applied. Courtesy Gregorio Espiritu (2013)



Results

Conclusion

PROPER Soil Fertility Management

- **Incorporating soil microbes + organic matter →**

SOIL BIORENOVATION

- **Healthy & Living Soil**
- **Healthy & Functioning Plant Root System**
- **Increase Productivity**
- **Reduce Production Cost**

www.belizeagroenterprise.com

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