MICRONUTRIENT UPTAKE / SOURCES / COMPATIBILITY

J. JULIAN SMITH, PHD

PRESIDENT, CZO AGRONOMICS. LLC

FFF FLUID TECHNOLOGY WORKSHOP, COLUMBUS, OH DECEMBER 6, 2017

CZO AGRONOMICS, LLC

CZO Agronomics, LLC

HISTORY

-Romans and Greeks – Pb, S, Hg, Fe
-1000 AD seaweeds in Ireland
-Rothamsted, England – N, P, K (manures) – 1800s
-1879 Anton de Bary, symbiosis
-Late 1800's Carlsberg labs, Denmark - yeasts
-France – late1800s – Burgundy/Bordeaux mixes – Cu, S, N, Ca
- 1909 Haber - Bosch
-US DuPont 1934 – ethylene bis-di metal dithiocarbamates – Mn, Zn
-Rothamsted, 1930's – green manures
-Agriform, California 1937, Florida – citrus / nitrates, urea (biuret)
-Michigan State, late 50s – multiple nutrients and crops, first evaluation of absorption T50 times
-Plains – urea grain protein
-1970s Trichoderma spp., bugs and extracts
-UK – NPK grains, potatoes, beets, canola 1980s
-US 1980s – now – soil microbes (Bt) and extracts, stimulants and crop protection, P solubilization
-Humic / fulvic acids, hormones, novel compounds

CZO Agronomics, LLC

TRUISM….

- PLANTS CAN'T RUN AWAY SO THEY NEED TO BE SMART ENOUGH TO SURVIVE IN SITU

CZO Agronomics, LLC

GENETICS AHEAD

Drought tolerance

Nutritional

- Constitution
- Taste
- Quality

Nutrient use efficiency

Non-conventional use e.g. B/N, Zn/Ca, Ni/Zn, SAR, nutrient solubilization, phylloplane / sphere, rhizoplane / sphere (exudates)

CZO Agronomics, LLC

NUTRITION

- MALNUTRITION NOW ACCOUNTS FOR 45 PERCENT OF ALL DEATHS OF CHILDREN UNDER 5 WORLDWIDE – **2.6 MILLION CHILDREN LOST**
  MEDECINS SANS FRONTIERS
- 30% WORLD POPULATION DEFICIENT IN IRON
  - ANEMIA, HEARING LOSS (PENN STATE)
  - IN UK, POST-OPERATIVE PATIENTS GIVEN GUINNESS!

CZO Agronomics, LLC

AGRONOMY

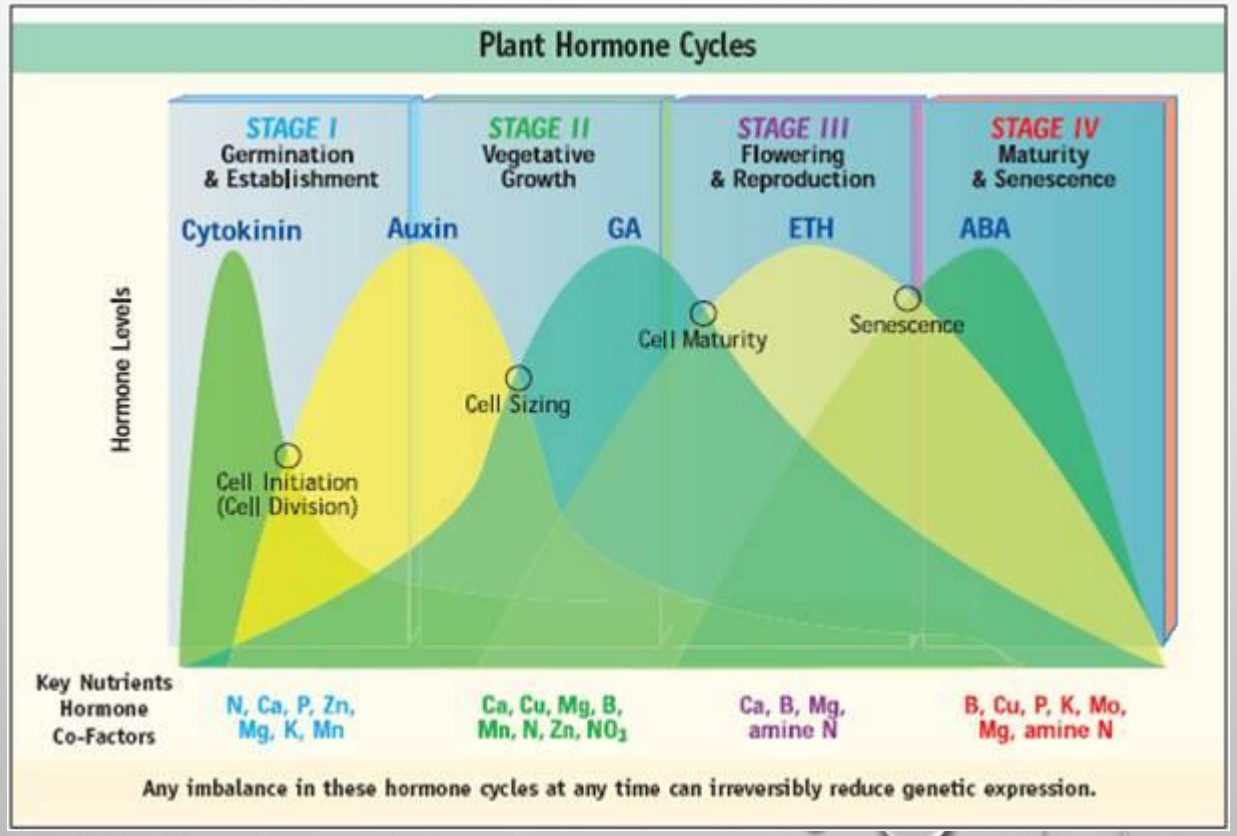
-Many definitions – for us, let us stay with positive economics of favorable gene expression mediated by our advice and inputs

-Disruptive technologies and strategy for innovation – be very careful and selective

-Creating ROI at every level from dirt to dinner plate

CZO Agronomics, LLC

BASIC PHYSIOLOGY



DEFINE PHYSIOLOGY

-The science of the ***function*** of living systems

-Whole crop

-Plant

-Organ

  -Leaf

  -Root

  -Fruit / Tuber

  -Seed

-Cellular

-Organelle – chloroplast, mitochondria

-Bio-molecules (execute chemical or physical function in living system)

CZO Agronomics, LLC

PHYSIOLOGICAL TOOLS

- GENETICS
  - GENOME
  - GENES
  - GENOTYPE
  - PHENOTYPE (THAT WOULD BE US)
- GMO VS CRISPR-CAS9 – NOW –CPF1
  - GENETIC SCISSORS
  - PROMETHEUS / ETHICS

CZO Agronomics, LLC

ROLE OF CL, CA, ZN AND B IN MINERAL NUTRITION OF ROW CROPS – A PHYSIOLOGICAL OVERVIEW

- CONSTITUTIVE
  - SOMETIMES REFERRED TO AS *STRUCTURAL*
    - CELL WALL AND MEMBRANE INTEGRITY
    - DISEASE AND PEST RESISTANCE
    - STORAGE QUALITY
    - PROTEIN STRUCTURE (ENZYME AND CO-ENZYME)
- CHEMICAL
  - METABOLIC PROCESSES
  - REGULATION
  - MESSENGERS
  - HORMONE, PROTEIN AND CARBOHYDRATE SYNTHESIS
- FUNCTIONAL CONSTITUTIVE / CHEMICAL CROSS-OVERS BETWEEN ZN, CA AND B
- PRODUCT RATIONALE

CZO Agronomics, LLC

PHYSIOLOGICAL TOOLS

-We are no longer curing deficiencies, at worst we pre-empt or over-ride (transient deficiencies)

-The products and solutions we offer are best considered as physiological tools to assist maximal gene expression

CZO Agronomics, LLC

BIOLOGICAL AND PHYSIOLOGICAL TARGETS

- Food
  - -Fruit, seed, stem, roots, leaves
- -Fiber
  - -Flower / seed, stems, tubers
- -Fuel
  - -Seed, stalks, leaves
- -Fun
  - -Leaves, flowers

CZO Agronomics, LLC

TARGET MANIPULATION

-Seed

-Abundance, germ efficiency, seed mass, oil / protein content, storage

-Leaf

-Longevity, mineral content and sink available, strength, respiration / photosynthetic area and duration

-Whole plant

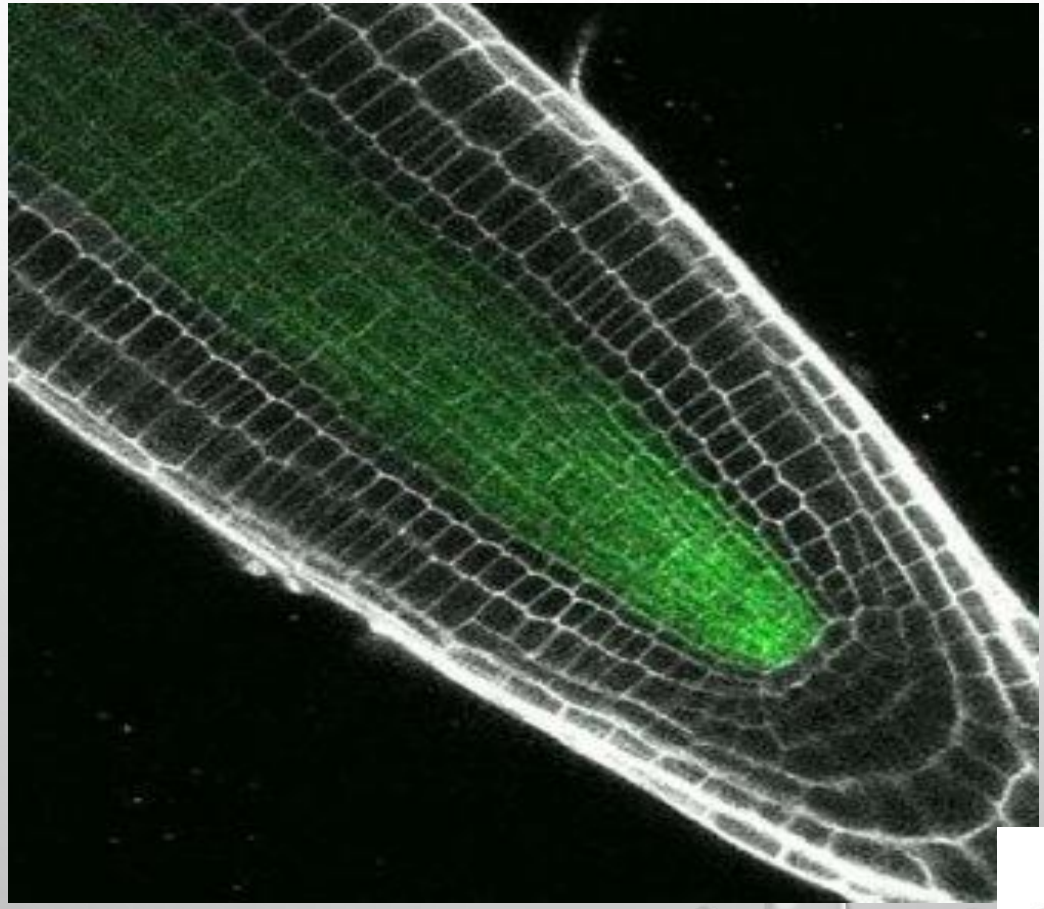
-Plant growth rate, architecture (height, phyllotaxis etc), fiber and sugar content, source / sink relationships

CZO Agronomics, LLC

LEAF SHAPE – STANDARD COTTON VS. OKRA COTTON

CZO Agronomics, LLC

ROOT TIP CELLS – GENERALISTS TO SPECIALISTS



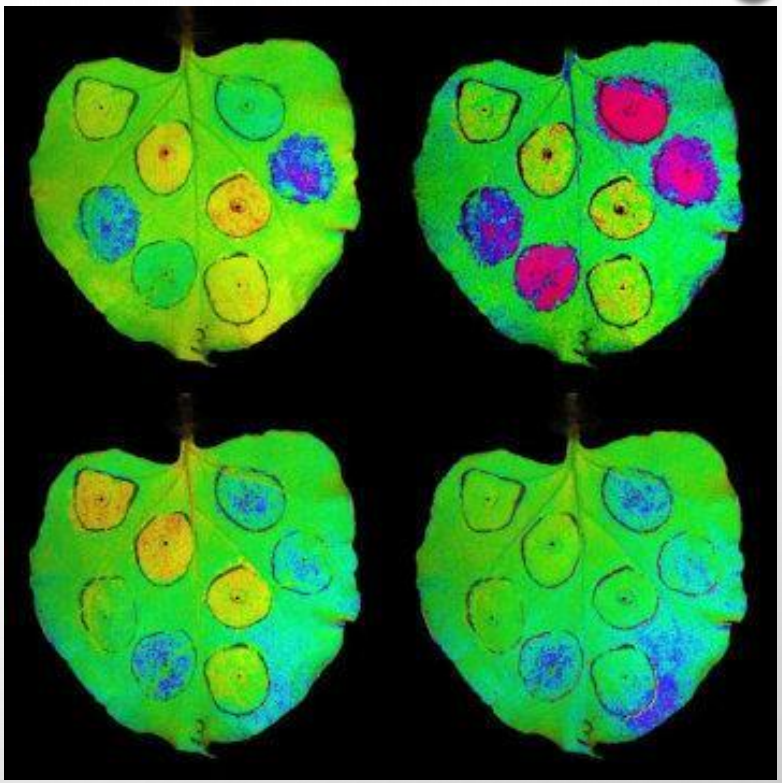
CZO Agronomics, LLC

PHOTOSYNTHETIC ADVANCES

-Photonic crystals reflect blue wavelengths but absorb red and green in low light (begonias, forest floor) – slows gap between incoming and reflected light thus improving photosynthesis

-Genes protect leaf against high light intensity damage, switch off to speed up photosynthesis after shade

-Plants yield higher with fewer leaves (shade effect)



CZO Agronomics, LLC

CONFUSED?

CZO Agronomics, LLC

SOIL APPLICATIONS

-Seed treatment / inoculation

-Starter

-Irrigation

-Drench

-Limits with conventional inputs such as fungicides, insecticides

CZO Agronomics, LLC

FOLIAR APPLICATIONS

-Much maligned in “conventional” circles
    -Cure all vs. agronomic proven supplement
    -Muck and mystery vs. proven solutions
    -Ignorance at “research” level is a hurdle (disparate disciplines)
-Multiple ride opportunities?
    -Glyphosate / herbicide
    -Fungicide
    -Corrective / compensatory / additive aspects

CZO Agronomics, LLC

DELIVERY CHEMISTRIES

- SOIL
  - CHELATES, STRONG COMPLEXES
  - SOIL AND CHEMICAL COMPATIBILITY
- FOLIAR
  - WEAK COMPLEXES
  - PLANT ANALOGS
  - ADJUVANTS
  - TRANSLAMINAR AND TRANSLOCATION
  - PLANT (NON-PHYTO) AND CHEMICAL COMPATIBILITY

CZO Agronomics, LLC

Inorganic

Water Soluble
- Nitrates
- Chlorides
- Sulfates
- Sodium Salts
- Potassium Salts
- Ammonium Salts

Not Water Soluble
- Carbonates
- Phosphates
- Silicates
- Hydroxides
- Oxides

Low Molecular Weight

Organic

Complexing Agents

Sugar Alcohols

Low Molecular Weight Acids
- Citric
- Oxalic
- Tartaric

- Na Glucoheptonate
- Lignin Compounds
- Fulvic Acids
- Humic Acid
- Amino Acids

High Molecular Weight

Chelating Agents
- EDTA
- DTPA
- HEEDTA
- HEDTA
- Citric Acid
- NTA

CZO Agronomics, LLC

CROP PROTECTION

-Generally speaking a healthy plant / crop is more resistant to…

- -Fungi (balance N, green manure)
- -Insects
- -Weeds
- -Nematodes

-Resistance vs. Tolerance

-Antagonism vs. “cidal”

CZO Agronomics, LLC

INSECTICIDES

-Leaf chemistry and structure
-Boron, Zn, Cu
    -Chemical composition
-SAR is real
-Ultra-violet and reflectance
-Physical / Structural barriers
-Predation, antagonism and “cidal”

CZO Agronomics, LLC

SOMEONE SMELLS – LEAF ODORS?

CZO Agronomics, LLC

BIOLOGICALS, BIO-STIMULANTS, PGR ??

-Confusion of definitions, regulation, claims – this is not GMO

-Abiotic / biotic – diversity of live/dead bugs and compounds

-Nutrient efficiency, plant regulation, insect / disease suppression, genetic expression, seed enhancement, stress management (water, temp), post-harvest, light utilization, xenobiotic metabolism (herbicide stress)

-Traits cross below ground (e.g. root architecture) and leaf (e.g. life-span, LAI / PAR) – spectral phenotyping

CZO Agronomics, LLC

TOOLS OF THE TRADE

-Organisms
    -PGPR
    -Inoculants
-Metabolites
    -Fermentation products
    -Synthetic extracts
-Plant extracts
    -Oils
    -Hormones (seaweed)
    -Humics / fulvics?
-Epigenetics – DNA / RNA transcription controls

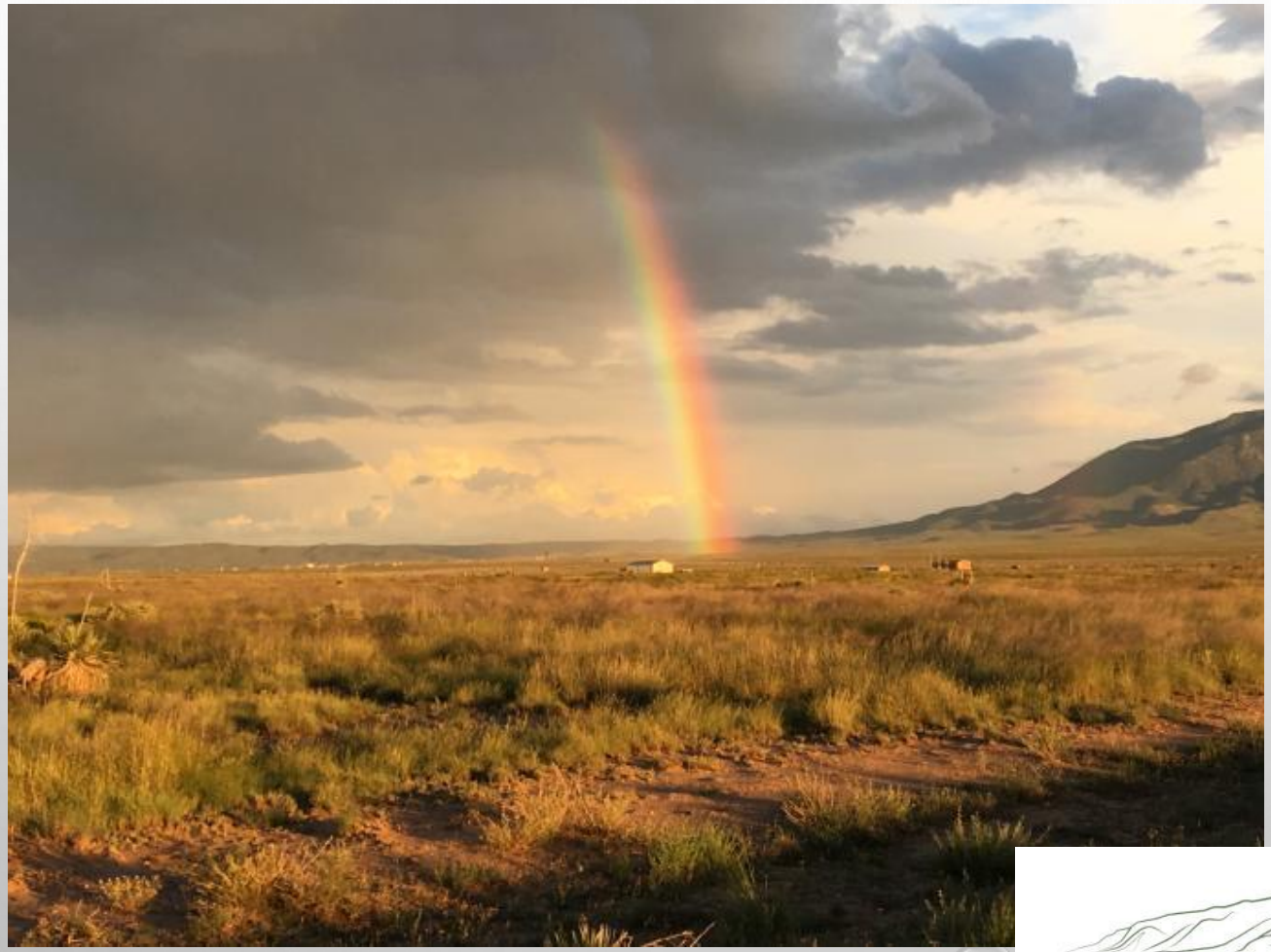
CZO Agronomics, LLC

WHY IS ALL THIS IMPORTANT? AGRICULTURAL SUSTAINABILITY?

- SERIOUS QUESTION? FEED THE WORLD ETC….
- QUALITY OF FOOD AND FEED
  - VITAMIN, MICROELEMENT, PROTEIN
- CROP PERFORMANCE
  - WATER, NUTRIENT EFFICIENCY
- INDUSTRIAL
  - PHARMACEUTICAL, PLASTIC
- FIBER
- FUEL
- QUANTUM PHYSICS
- REAL SCIENCE AND FUNDING

CZO Agronomics, LLC

SOMEWHERE OVER THE RAINBOW….



CZO Agronomics, LLC

SCIENCE TO WATCH….

- PLANT / SOIL FEEDBACK
  - ROOTS (GENES) INTERACT WITH FUNGI AND BACTERIA – HUGE RAMIFICATIONS FOR BIOLOGICAL INPUTS AND NPK
- CRISPR-CAS9, GENETIC SCISSORS – NOT GMO? KNOW OVER NO…(R. SAIK)
- APARTMENT BUILDINGS / OFFICE BLOCKS – CLIMATE CONTROL = YEAR ROUND GROWING
- 3-D PRINTING CELL-PODS AS HOME APPLIANCE
  - PLANT CELL TO MEAL "CELLULAR AGRICULTURE"
- HUMAN AGRICULTURE DATED TO ~12K YEARS AGO, FIJIAN ANTS SHOWN TO SOW SEEDS AND FERTILIZE ~3 MILLION YEARS AGO

CZO Agronomics, LLC

GLOBAL WARMING / COOLING AMMONIA DYNAMICS?

CZO Agronomics, LLC

THANK YOU!


CZO Agronomics, LLC
Solutions for Solution Providers
575.551.6294
CZO Agronomics, LLC