MICRONUTRIENT UPTAKE / SOURCES / COMPATIBILITY

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HISTORY

- Romans and Greeks – Pb, S, Hg, Fe
- 1000 AD seaweeds in Ireland
- 1879 Anton de Bary, symbiosis
- Late 1800’s Carlsberg labs, Denmark - yeasts
- France – late 1800s – 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
TRUISM....

• PLANTS CAN’T RUN AWAY SO THEY NEED TO BE SMART ENOUGH TO SURVIVE IN SITU
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)
NUTRITION

• Malnutrition now accounts for 45 percent of all deaths of children under 5 worldwide – **2.6 million children lost**

  **Medecins Sans Frontieres**

• 30% world population deficient in iron
  • Anemia, hearing loss (Penn State)
  • In UK, post-operative patients given Guinness!
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
BASIC PHYSIOLOGY

Plant Hormone Cycles

Stage I: Germination & Establishment
- Cytokinin

Stage II: Vegetative Growth
- Auxin
- GA

Stage III: Flowering & Reproduction
- ETH

Stage IV: Maturity & Senescence
- ABA

Key Nutrients
- N, Ca, P, Zn, Mg, K, Mn
- Ca, Cu, Mg, B, Mn, N, Zn, NO₃
- Ca, B, Mg, amine N
- B, Cu, P, K, Mo, Mg, amine N

Any imbalance in these hormone cycles at any time can irreversibly reduce genetic expression.
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)
PHYSIOLOGICAL TOOLS

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

- Food
  - Fruit, seed, stem, roots, leaves
- Fiber
  - Flower / seed, stems, tubers
- Fuel
  - Seed, stalks, leaves
- Fun
  - Leaves, flowers
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
LEAF SHAPE – STANDARD COTTON VS. OKRA COTTON
ROOT TIP CELLS – GENERALISTS TO SPECIALISTS
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)
CONFUSED?

I THINK I PROMISED TO HAVE 3 BEERS AND BE HOME BY 10.

I ALWAYS GET THOSE 2 MIXED UP.
SOIL APPLICATIONS

-Seeds treatment / inoculation
- Starter
- Irrigation
- Drench

-Limits with conventional inputs such as fungicides, insecticides
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
DELIVERY CHEMISTRY

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

Inorganic
- Water Soluble
  - Nitrates
  - Chlorides
  - Sulfates
  - Sodium Salts
  - Potassium Salts
  - Ammonium Salts
- Not Water Soluble
  - Carbonates
  - Phosphates
  - Silicates
  - Hydroxides
  - Oxides

Organic
- Complexing Agents
  - Sugar Alcohols
    - Low Molecular Weight Acids
      - Citric
      - Oxalic
      - Tartaric
  - Na Glucoheptonate
  - Lignin Compounds
  - Fulvic Acids
  - Humic Acid
  - Amino Acids
- Chelating Agents
  - EDTA
  - DTPA
  - HEEDTA
  - HEDTA
  - Citric Acid
  - NTA
  - High Molecular Weight

Low Molecular Weight

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”
INSECTICIDES

- Leaf chemistry and structure
- Boron, Zn, Cu
  - Chemical composition
- SAR is real
- Ultra-violet and reflectance
- Physical / Structural barriers
- Predation, antagonism and “cidal”
SOMEONE SMELLS – LEAF ODORS?
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
TOOLS OF THE TRADE

- Organisms
  - PGPR
  - Inoculants
- Metabolites
  - Fermentation products
  - Synthetic extracts
- Plant extracts
  - Oils
  - Hormones (seaweed)
  - Humics / fulvics?
- Epigenetics – DNA / RNA transcription controls
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
SOMEWHERE OVER THE RAINBOW....
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
GLOBAL WARMING / COOLING
AMMONIA DYNAMICS?
THANK YOU!