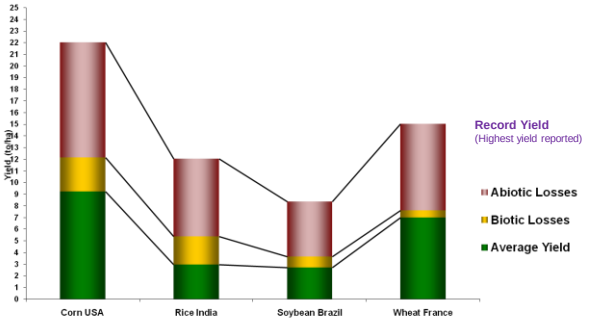
Abiotic Stress Primer
August, 2019

Biotic Vs Abiotic Stress

- ***Biotic stresses are caused by living organisms:***
  - insects
  - diseases
  - weeds
  - animals
- ***Abiotic stresses are environmental:***
  - temperature *(heat, cold)*
  - light *(ultraviolet, infra-red , white - low & high intensity)*
  - water *(drought, flood)*
  - soil conditions *(acidity, alkalinity, minerals, toxins etc.)*

Modern Agriculture May Lose as Much as Half its Productivity from Abiotic Stresses

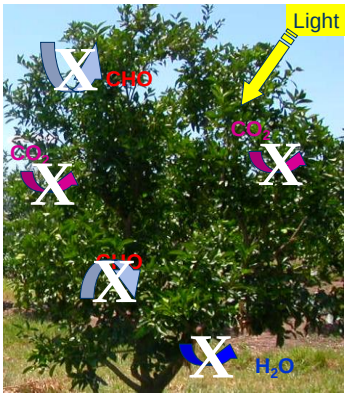


Buchanan, Gruissem, Jones: Biochemistry and Molecular Biology of Plants; American Society of Plant Physiologists, 2000, FAO

The Heat, Light and Water Stress Story Begins Much Earlier....

- Poor plant establishment
  - *increased re-planting*
  - *prolonged time to bearing in tree fruits*
- Lower yield of high quality fruit
  - *flower and fruit set issues*
  - *reduced sizing, despite thinning*
  - *twinning and reduced flower primordia (stone fruit)*
- Decreased water use efficiency
- Sunburn

When Stress Reaches Critical Level Photosynthesis Slows and Eventually Stops



Photosynthesis Stops

=> *No Carbohydrate*

Why Does This Matter?

- Less carbohydrate may lead to:
  - *smaller fruit*
  - *fewer fruit (increased fruit drop)*
  - *reduced shoot and root growth*
  - *poor development of reproductive tissues*
    - number and quality of next season's flowers
    - periodicity

less carbohydrate = < productivity = < returns

Heat, Light, Water

- All essential for plant growth and crop production
- Too much or too little can cause problems
- All are related in their impact on plants
  - *Too little water can cause plants to overheat*
  - *Too much light raises temperatures and increases water use*
  - *Too high or low temperatures impair photosynthesis and increases water loss from the crop and soil*

What Happens When There's Too Much?

- Light radiation (UV, visible, IR) is energy
- Excess energy added to plants is converted to heat
- Plants use water in an attempt to keep cool
- At high temperatures, plants begin to malfunction, systems shut down.....
- .....shut down systems cause damage to the crop

Photosynthesis is Affected First

- **As stresses increase, photosynthesis decreases**
  - photo-inhibition affects electron transport
  - capture of CO_2 is decreased
  - chloroplasts continue to absorb light
  - light energy that is not used in photosynthesis is converted to free radicals (O^-)
  - free radicals damage leaf tissues
  - plants use stored carbohydrate to repair damage

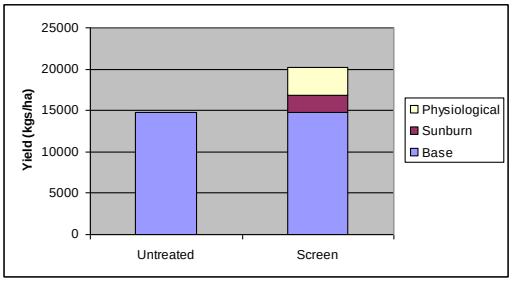
Additional Effects

- Disruption of membrane structure
  - Can stabilize short term with chaperonin molecules
  - Stabilize long term by acclimatization
- Disruption of proteins
  - Secondary, tertiary structure
  - Can stabilize with chaperonins
  - Alternative forms through genetic up or down regulation, epigenetic changes, protein modifications

How do plants cope with abiotic stress?

- Fast response - seconds to minutes:
  - Stomatal responses
  - Possible role of nitric oxide (NO) for stress signalling
- Mid-term response- minutes to hours to days
  - Redox state of cell altered – ascorbate, glutathione may be buffers
  - Activation of defence biochemistry
    - Salicylate, MAPK Kinase cascades, chaperonins, ROS coping mechanisms
- Long term response – days to weeks
  - Acclimatization – changes in lipid saturation, protein profile, epigenetic alternations/gene expression

Cooler Crops Yield More Quality Fruit

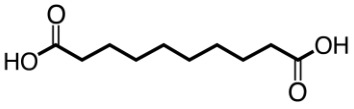


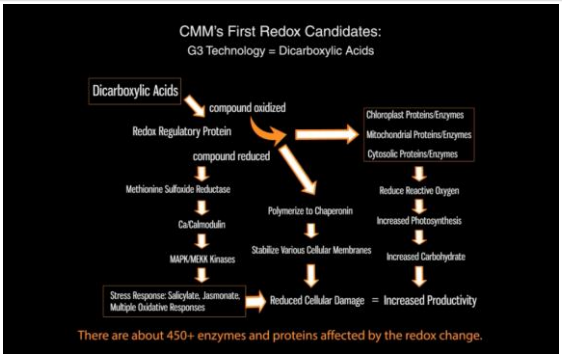
About Dicarboxylic Acids

- New technology for abiotic stress management
- Increases yield and quality of crops, increasing grower returns (ROI 3-10+X)
- A blend of dicarboxylic acids (dicarb)– which occur naturally in plants
- Patented in the US(3), Australia(2), Chile, South Africa, Brazil, Indonesia, Europe, other countries pending

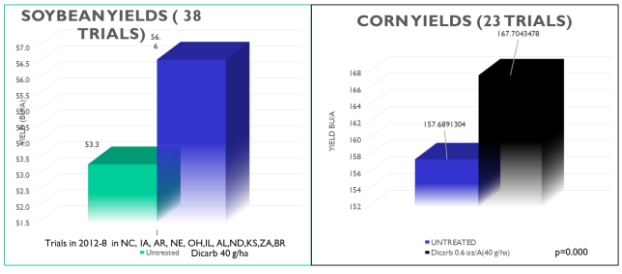
How Dicarb Works

- Activates and stimulates enzymes through thioredoxin
  - Regulates photosynthesis by impacting carbon capturing enzymes and reactive oxygen concentrations.
  - Regulates cellular redox states.
  - Impacts approximately 450+ enzymes, and has a direct or indirect impact on stress signaling cascade components, such as MAP kinases, SAR systems, calcium utilization.
  - Chaperonin activity
  - Epigenetic changes?





Yield Trial Results



Trial Data Australia 2009/10

Tomatoes							
	Rate	Aborted Flower per sq m	Sunburn Fruit per plot	Yield Red MT/ha	Yield Sunburn MT/ha	Total Yield MT/ha	Soluble Solids MT/ha
Untreated		13.3	45.0	99.5	17.5	121.7	4.5
Dicarb	8 gram ai/ha	5.0	21.3	131.0	6.6	137.6	6.2
LSD 0.05		2.4	9.4	10.6	3.5	10.9	0.5

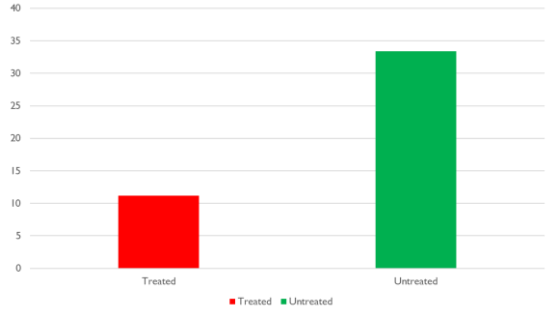
Apples						
	Rate	Fruit Diameter mm	% Fruit Commercial	Apple Size g/apple	Yield kg/tree	Marketable Yield kg/tree
Untreated		36.9	76.8	134.0	37.0	28.4
Dicarb	18 gram ai/ha	39.8	87.4	152.0	42.8	37.4
LSD 0.05		1.6	2.7	9.5	3.9	3.6

Wine Grapes					
	Rate	% Bunches Commercial	Yield kg/vine	Bunch Weight grams	Yield kg/ha
Untreated		70.3	2.1	56.9	5333.0
Dicarb	8 gram ai/ha	96.8	3.6	94.7	9230.0
LSD 0.05		13.6	0.5	14.9	1256.0

Citrus						
	Rate	Early Fruit Diameter mm	Fruit Number per cubic meter	Percent Sunburn	Fruit Diameter (mm)	Yield kg/M3 Canopy
Untreated		27.5	5.3	6.8	66.7	2.2
Dicarb	18 gram ai/ha	29.5	10.6	2.8	71.6	3.6
LSD 0.05		1.4	2.5	1.5	0.5	0.3

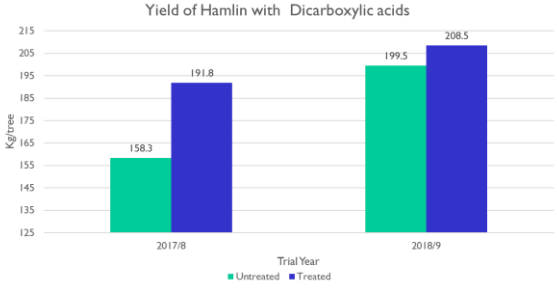
Citrus Yields Australia

- 2015 Replicated Trial, Cobram, VIC



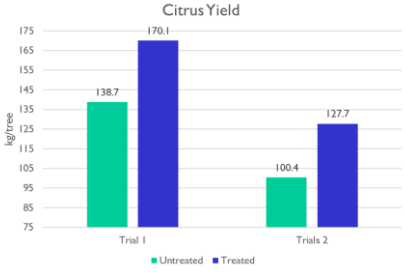
Results in Brazil

- Uniceres – Monte Azul Paulista



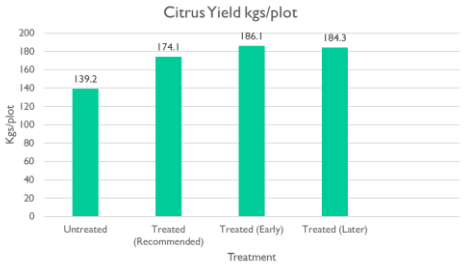
Results in Brazil

- Trials in Brotas



Results in Brazil

- Replicated trial by FarmATAC in Bebeduro



Results in Brazil

- Sunburn -Aquai

Sunburn Fruit per Tree

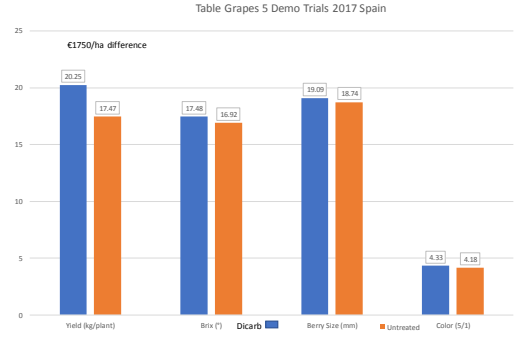
	Bad	Medium	Low	Loss cx/ha
Untreated	5.32	4.48	1.61	8.5
Treated	0.0	1.7	3.74	0.0

Results in Brazil

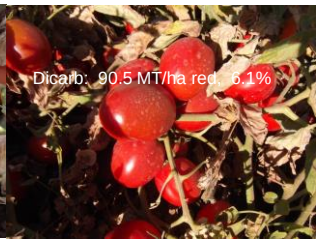
- Sunburn Trial

Citrus Recommendation in Brazil

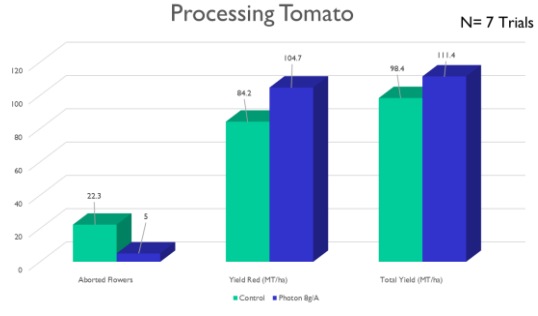
- 3 applications of 40 g/ha commercial product
  - Begin applications at flowering
  - Repeat every 20- to 25 days
  - Include surfactant
  - Sufficient water to cover, NOT to runoff



Tomato



Tomato Results



Potato

Yield Untreated 6.1 kgs, 145 g/tuber

Dicarb 6.7 kgs, 175 g/tuber

Drought Stress

Tomato Cold Stress

Untreated

Dicarb

About Dicarboxylic Acids

Dicarb has been used commercially in horticultural and agronomic crops :

- Australia – 7 years
- Chile - 6 years
- South Africa – 6 years
- Turkey – 5 years
- Others (USA, BR, Mex, etc) 3 or fewer seasons

- Provides excellent efficacy and high grower satisfaction.

Additional Considerations

- Blueberries, cherries, peppers, and other fruit have shown better firmness at harvest
- Increased postharvest storage has been observed in cherries, squash, tomatoes, peppers, other crops

CMM
crop microclimate management inc.

Thank you

For more information see:

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www.apexagro.com.br

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