Understanding the role of biostimulants in turfgrass management under drought stress

Diego Gómez de Barreda Ferraz
Polythecnic University of Valencia (Spain)
(diegode@btc.upv.es)

Biostimulants

NEW REGULATION (EU) 2019/1009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 June 2019 ON FERTILISING PRODUCTS

BIOSTIMULANT is a product stimulating plant nutrition processes independently of the product's nutrient content with the sole aim of improving one or more of the following characteristics of the plant or the plant rhizosphere:

(a) nutrient use efficiency,
(b) tolerance to abiotic stress,
(c) quality traits, or
(d) availability of confined nutrients in the soil or rhizosphere.

- Very disperse definition.
- No biostimulant classification.

Classification of Biostimulants for turfgrass science

1.- Humic and Fulvic acids

2.- Amino acids
- Single fre AA
- Mix of free AA
- Peptides

3.- Seaweed extracts

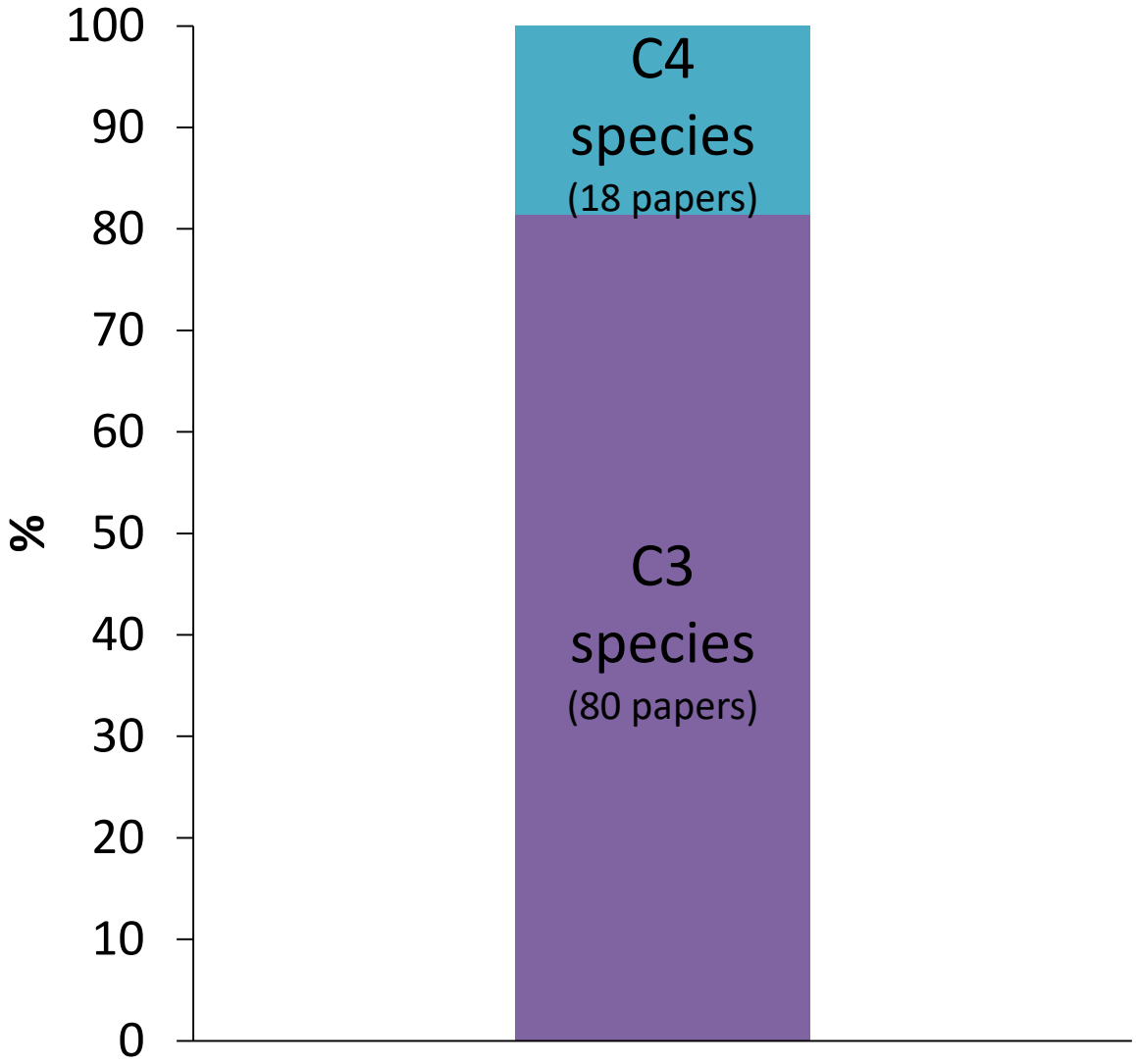
4.- Inorganic compounds

5.- Microorganisms
- Bacteria
- Fungi

According to 98 peer reviewed papers on biostimulants in turfgrass science

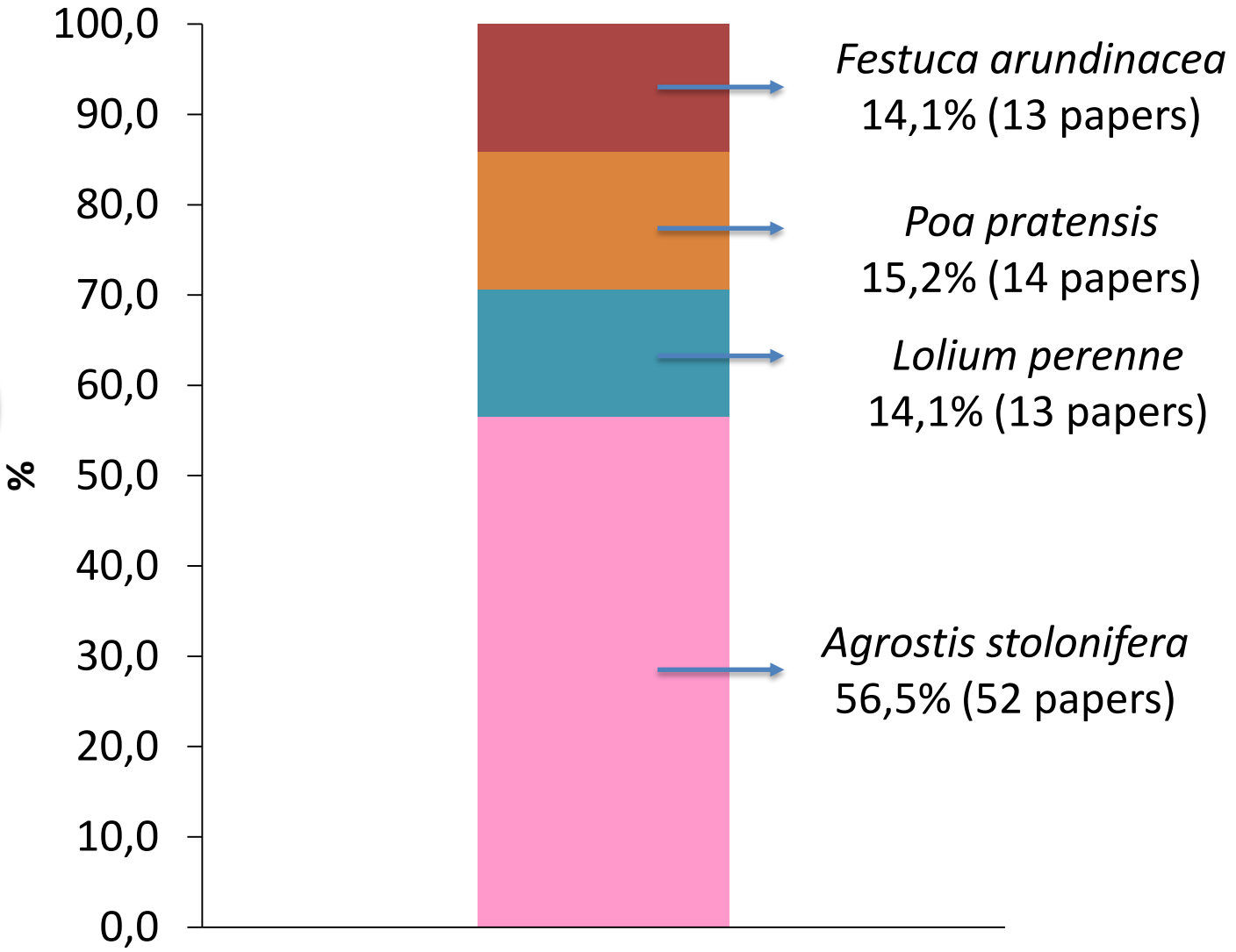
Peer reviewed papers dealing with biostimulants in turfgrass science

98 Studies



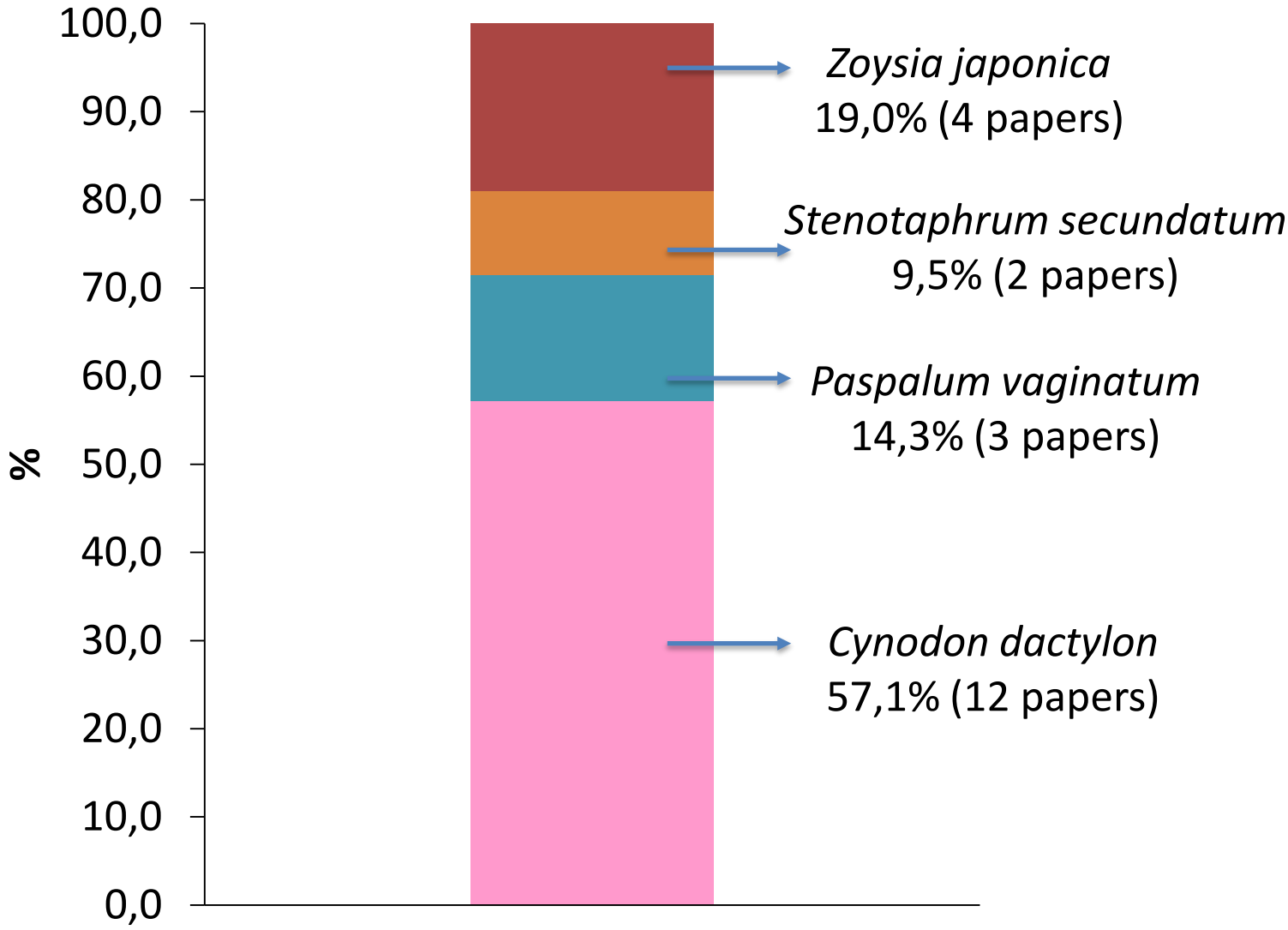
C3 turfgrass species with research on biostimulants

80 Studies



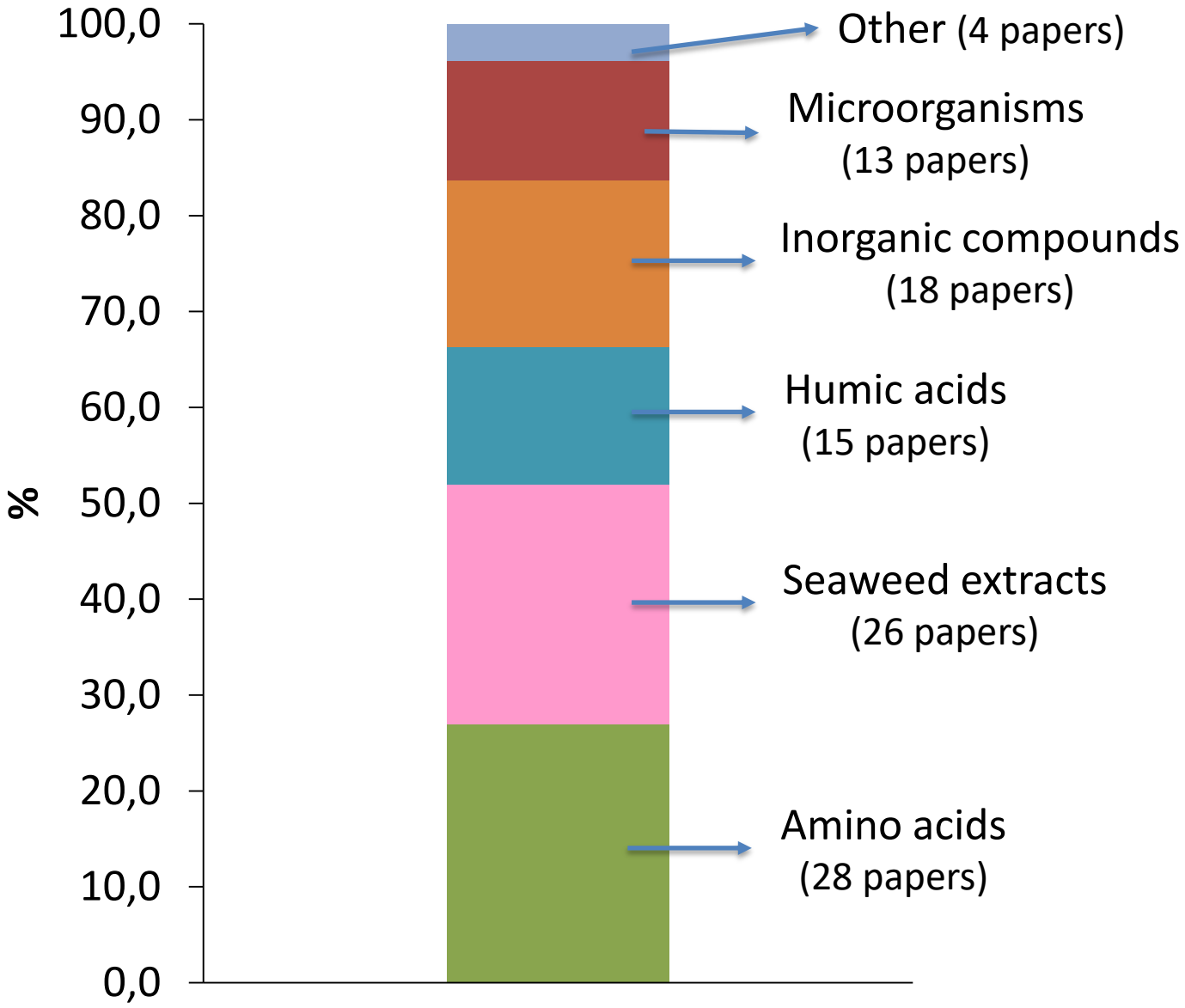
C4 turfgrass species with research on biostimulants

18 studies

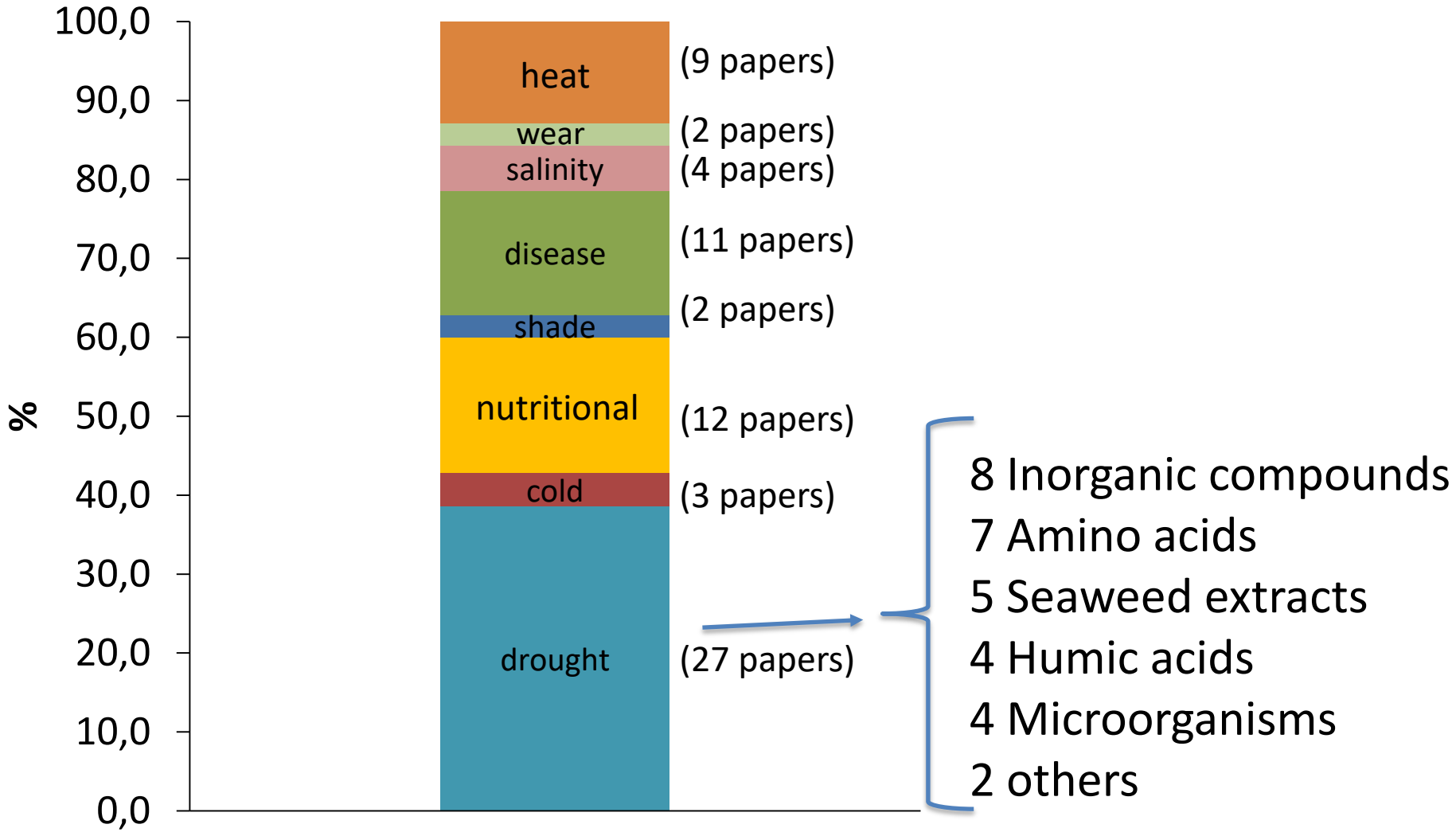


Type of biostimulants tested in turfgrass science

98 studies



Stresses tested on turfgrass science for biostimulant use



Drought stress

It occurs when soil water content is reduced to a point that causes negative effects on plant growth **(Fry and Huang, 2004).**

Drought takes place for several reasons

- Low rainfall events
- Temperature (heat)
- High radiation
- Management issues

- Species/cultivar wrong election
- Lack of water
- Salinity
- Low irrigation uniformity
- Poor putting green management
- Need to provoke a water stress for pest control

Salehi-Lisar and Bakhshayeshan-Agdam, 2016

In a water stress situation, plants

Search for water

Root growth

* Slow and not immediate process
* Depend on:
  a) Genetics
  b) Previous turf management

Try to Avoid lose of water

Transpiration avoidance

Stomata closure

Photosyntesis reduction

* As less CO_2 enters into the plant

Photorespiration increases in C3 species

* As RUBISCO enzyme is able to fix CO_2 and O_2

Try to keep cell turgor

Osmotic adjustment

* Ion accumulation (K^+)
* Osmolytes present

Excess of light ("electrons")

ROS increase

- Affect oxigen and produce Reactive Oxigen Species (ROS)

$O_2^{\cdot-}$ $^1O_2$ H_2O_2 $OH^{\cdot}$

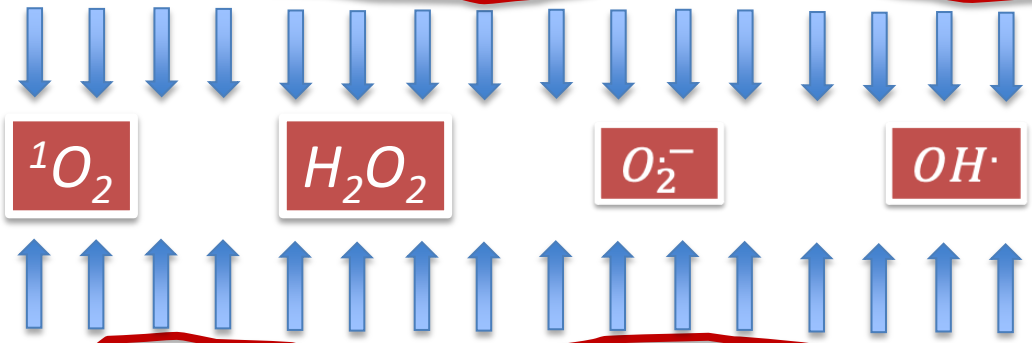
Net photosyntesis decresae

Lipid peroxidation

Cell leackage

Enzymatic anti-oxidants

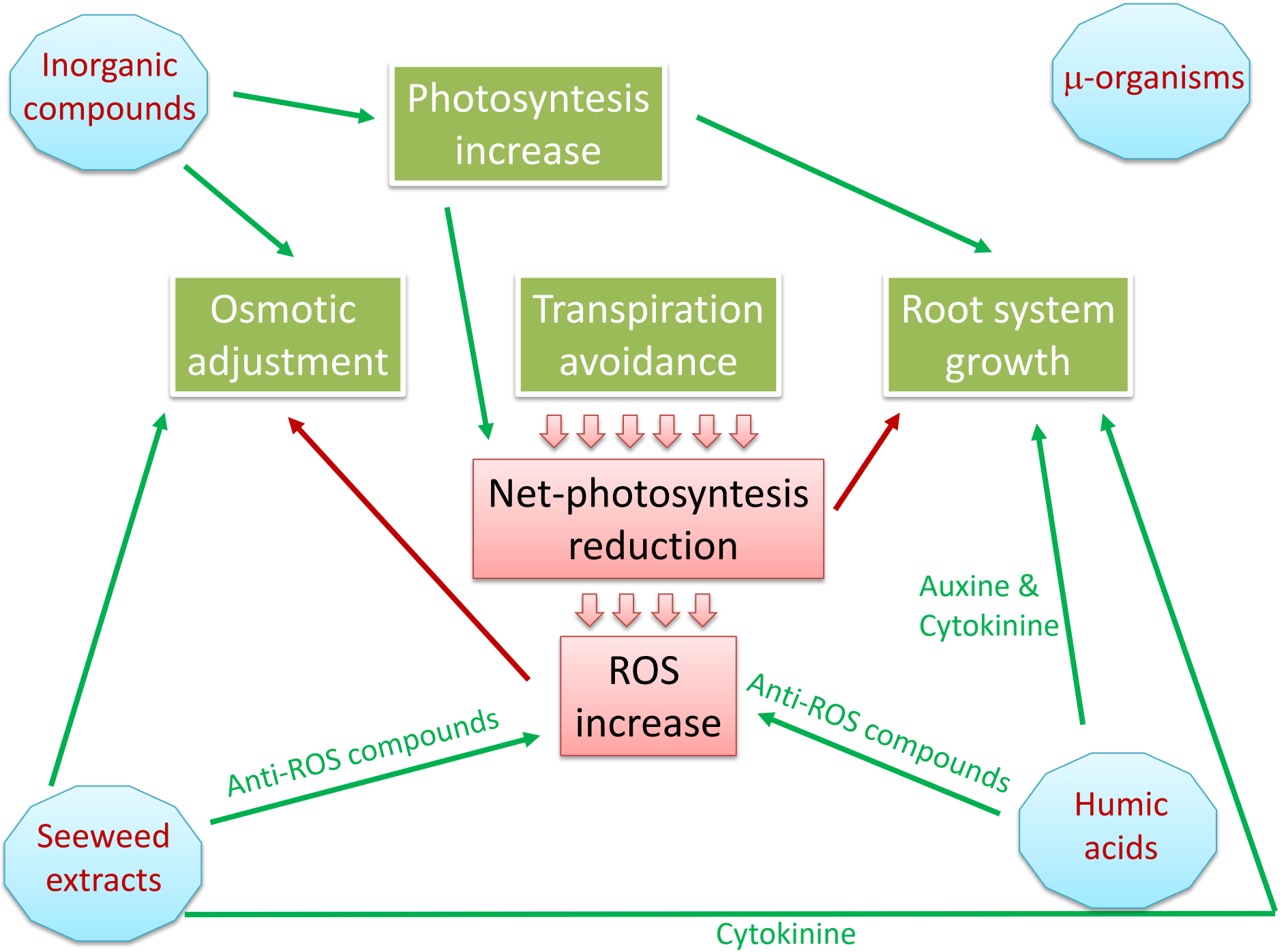
- Superoxide dismutase (SOD)
- Dehydroascorbate reductase (DHAR)
- Catalase (CAT)
- Monodehydroascorbate reductase (MDHAR)
- Gluthathione reductase (GR)
- Guaiacol peroxidase (PPX)

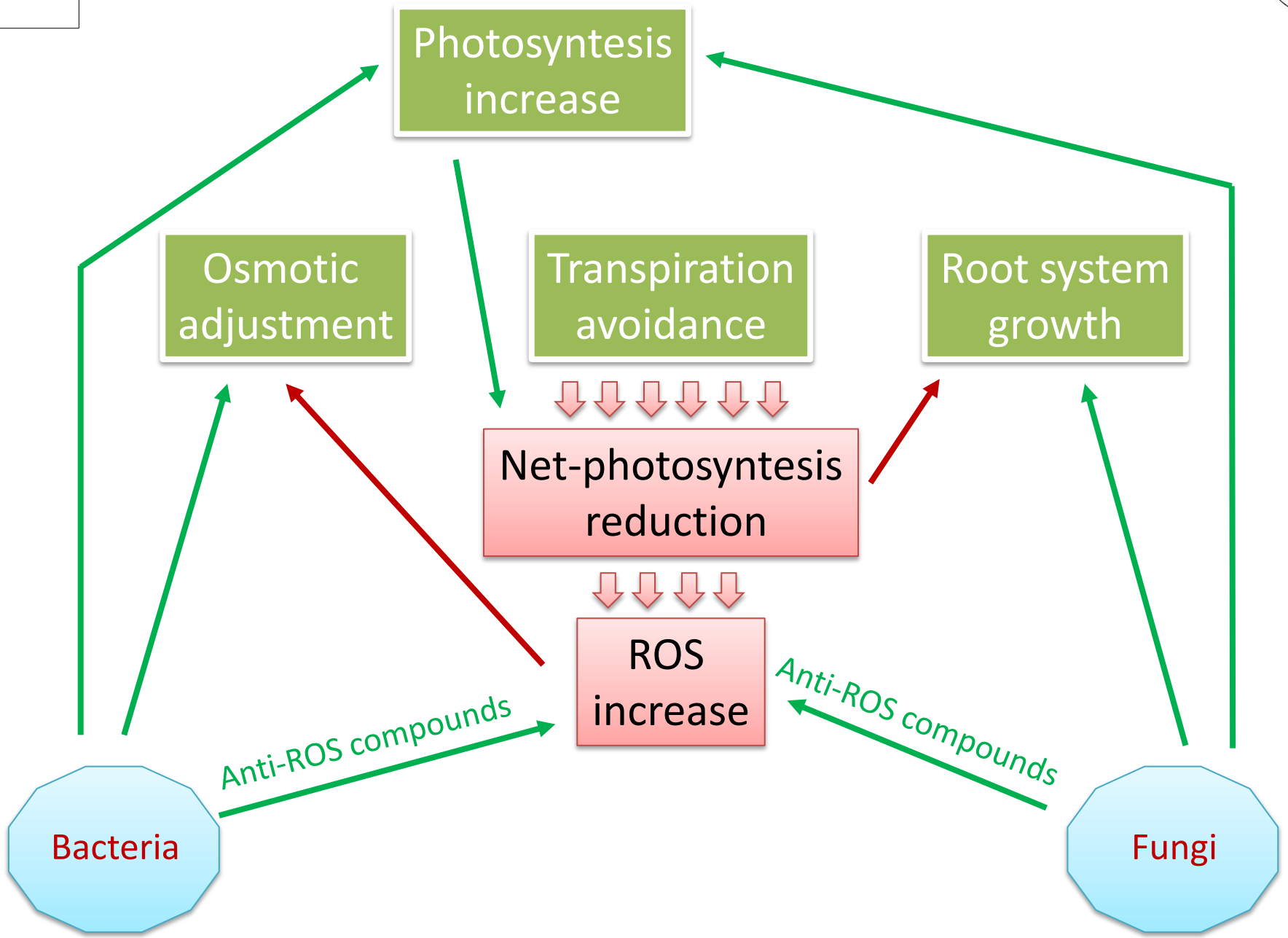


- Ascorbic acid
- Reduced glutathione (GSH)
- proline
- α-tocopherol
- Carotenoids, flavonoids

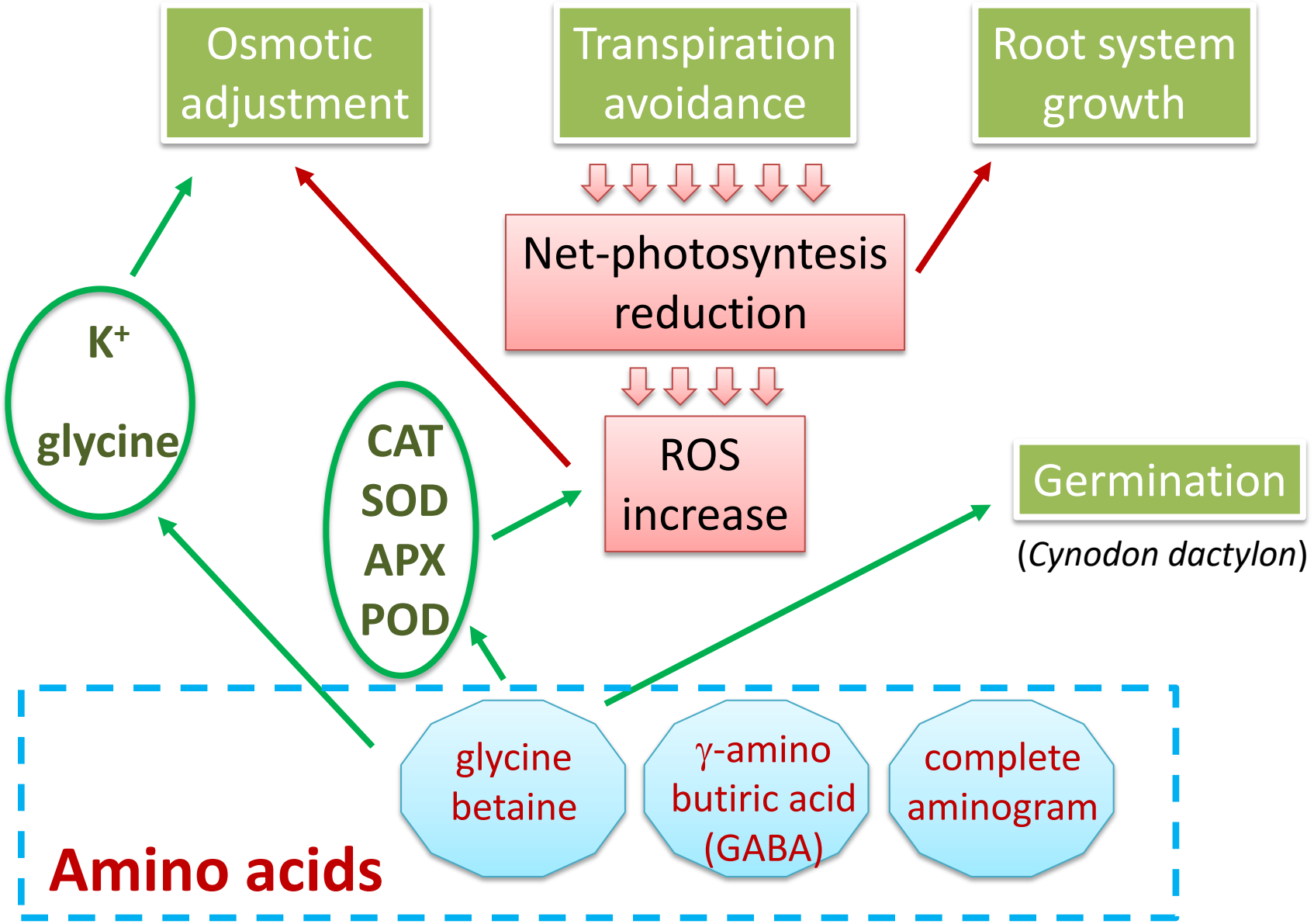
Non enzymatic anti-oxidants

Which is the role of each kind of biostimulant for turfgrass drought stress avoidance?


Inorganic compounds
Photosyntesis increase
µ-organisms
Osmotic adjustment
Transpiration avoidance
Root system growth
Net-photosyntesis reduction
ROS increase
Auxine & Cytokinine
Anti-ROS compounds
Anti-ROS compounds
Seeweed extracts
Humic acids
Cytokinine


Photosyntesis increase
Osmotic adjustment
Transpiration avoidance
Root system growth
Net-photosyntesis reduction
ROS increase
Anti-ROS compounds
Anti-ROS compounds
Bacteria
Fungi

What about amino acid based biostimulants?



How do each biostimulant type deal with drought stress?

Osmotic adjustment

Transpiration avoidance

Root system growth

Net-photosyntesis reduction

ROS increase

malic acid
lactic acid
gluconic acid
malonic acid
ribonic acid

GABA
glycine
oxoproline
threonine
aspartic acid
glutamic acid
serine
valine
proline

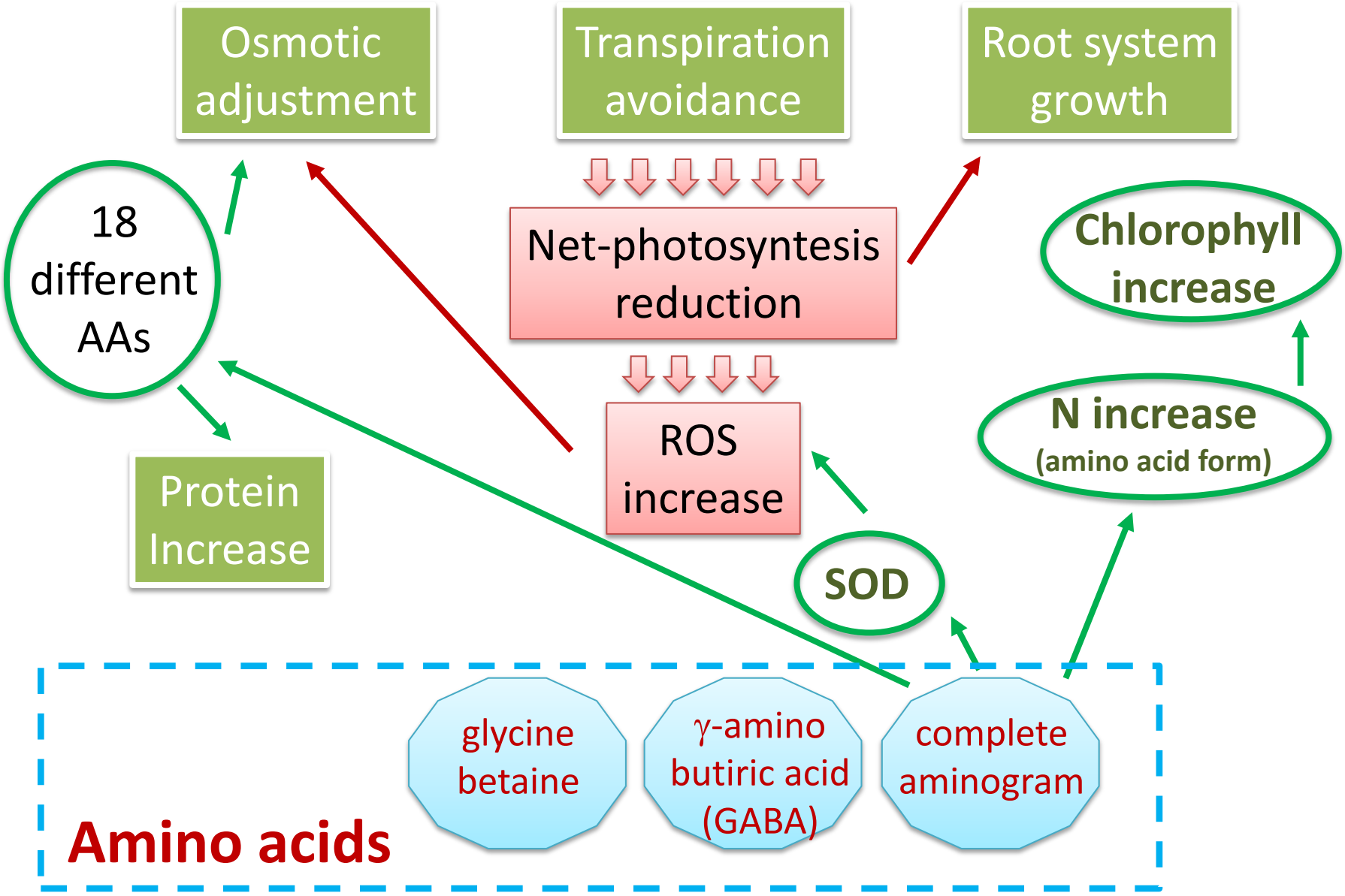
glycine betaine

γ-amino butiric acid (GABA)

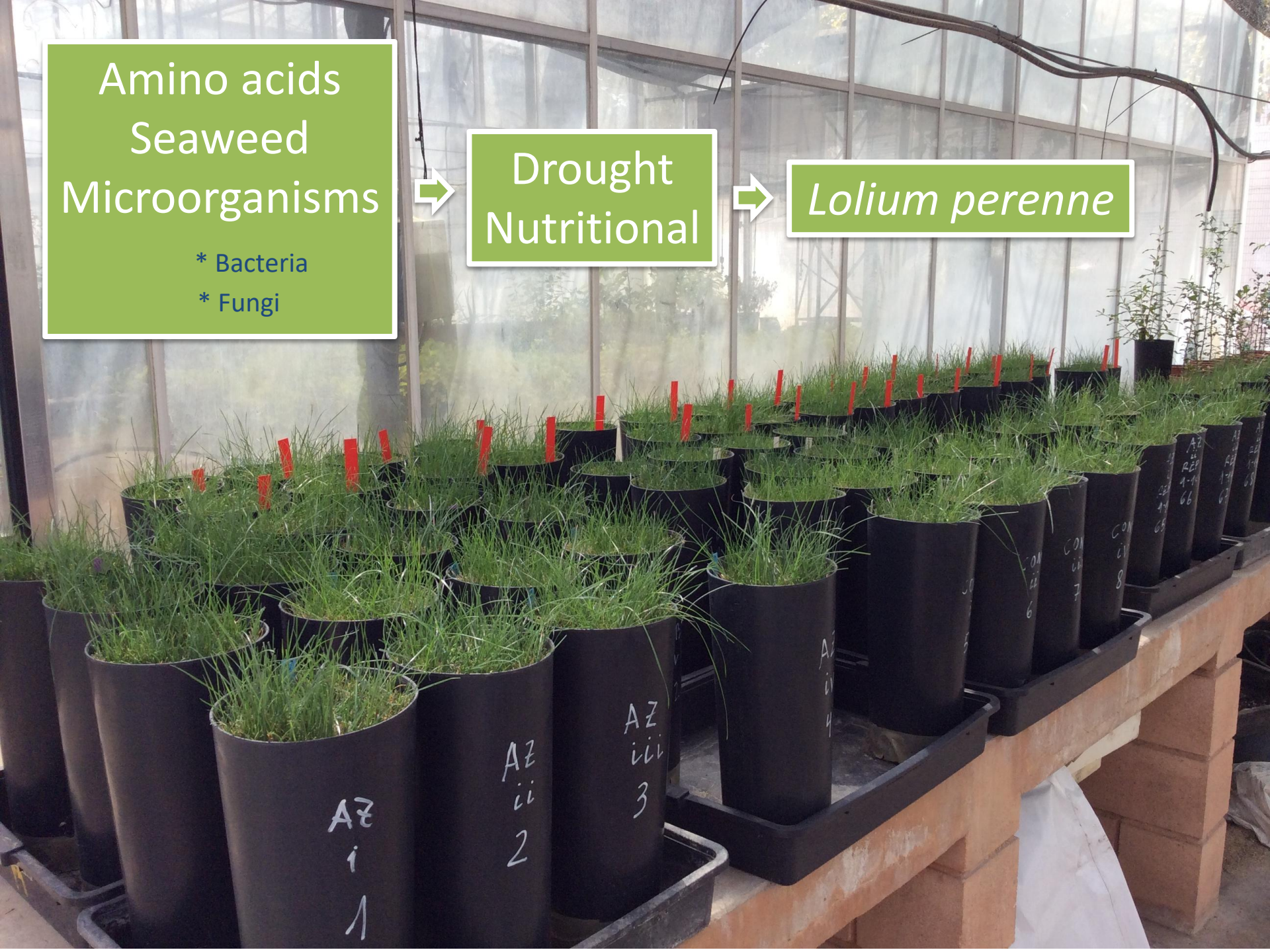
complete aminogram

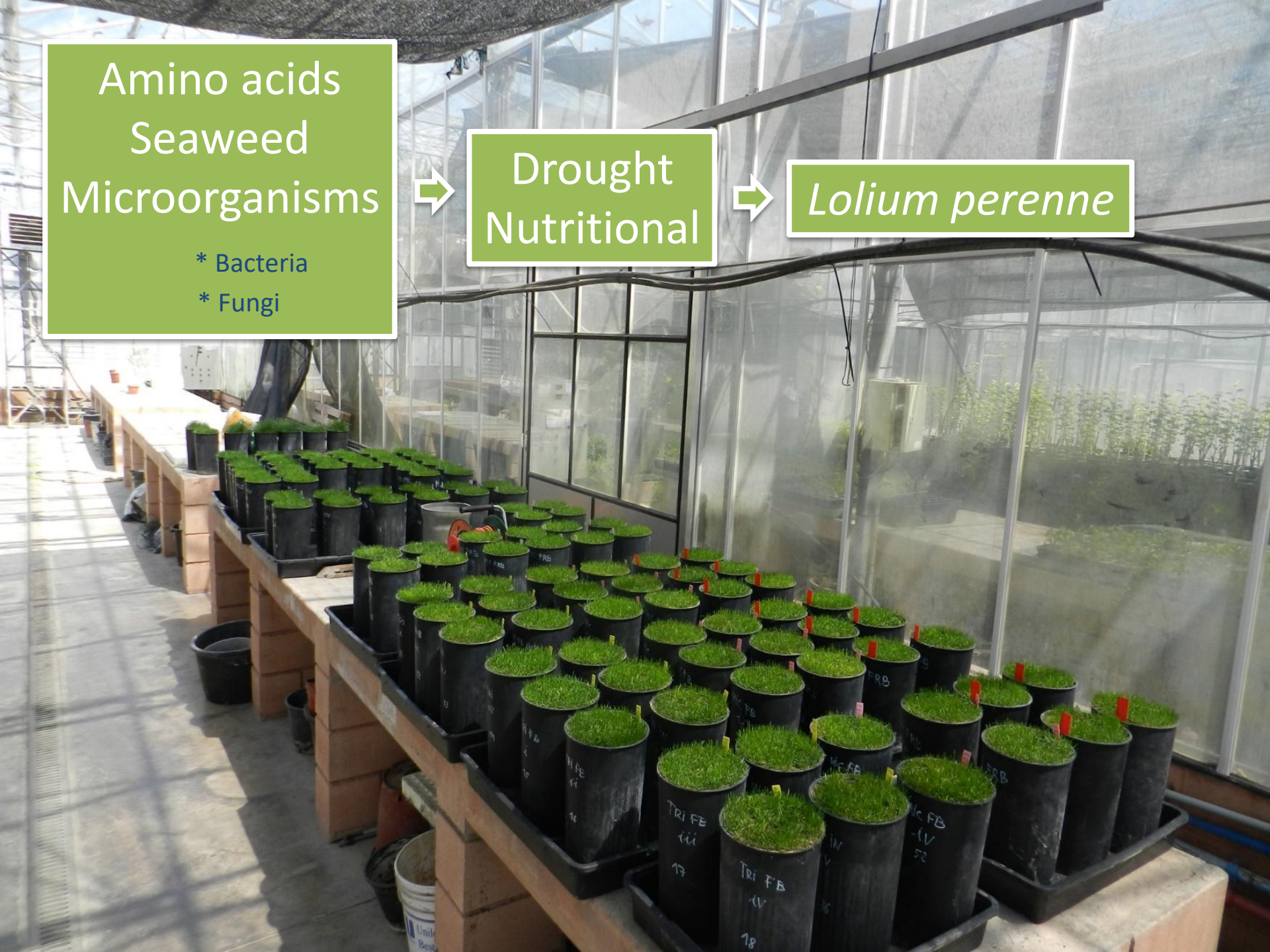
Amino acids

How do each biostimulant type deal with drought stress?



Research on biostimulants for turfgrass science at the Polytechnic University of Valencia


Amino acids
Seaweed
Microorganisms
* Bacteria
* Fungi
Drought
Nutritional
Lolium perenne
AZ i 1
AZ ii 2
AZ iii 3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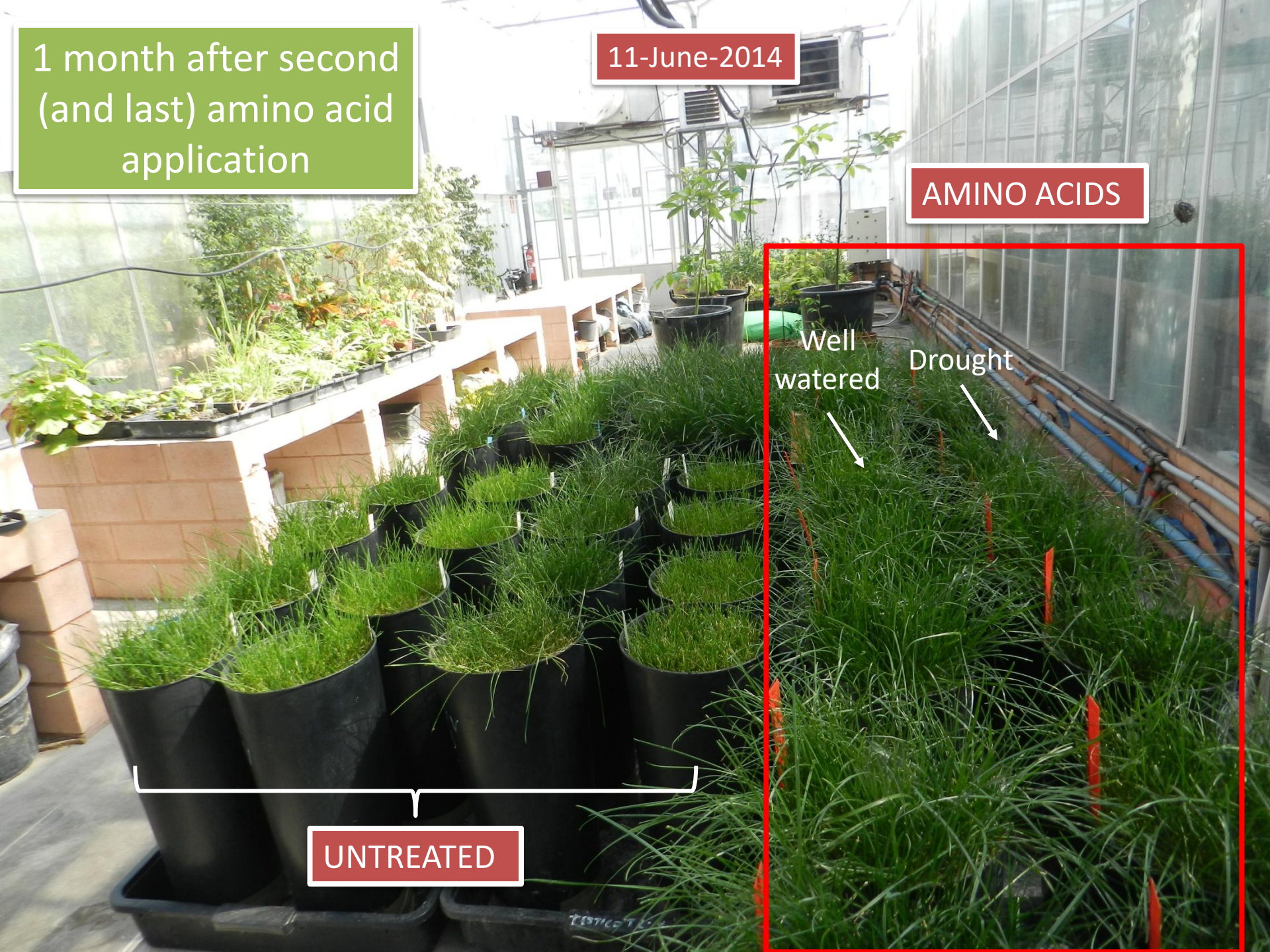
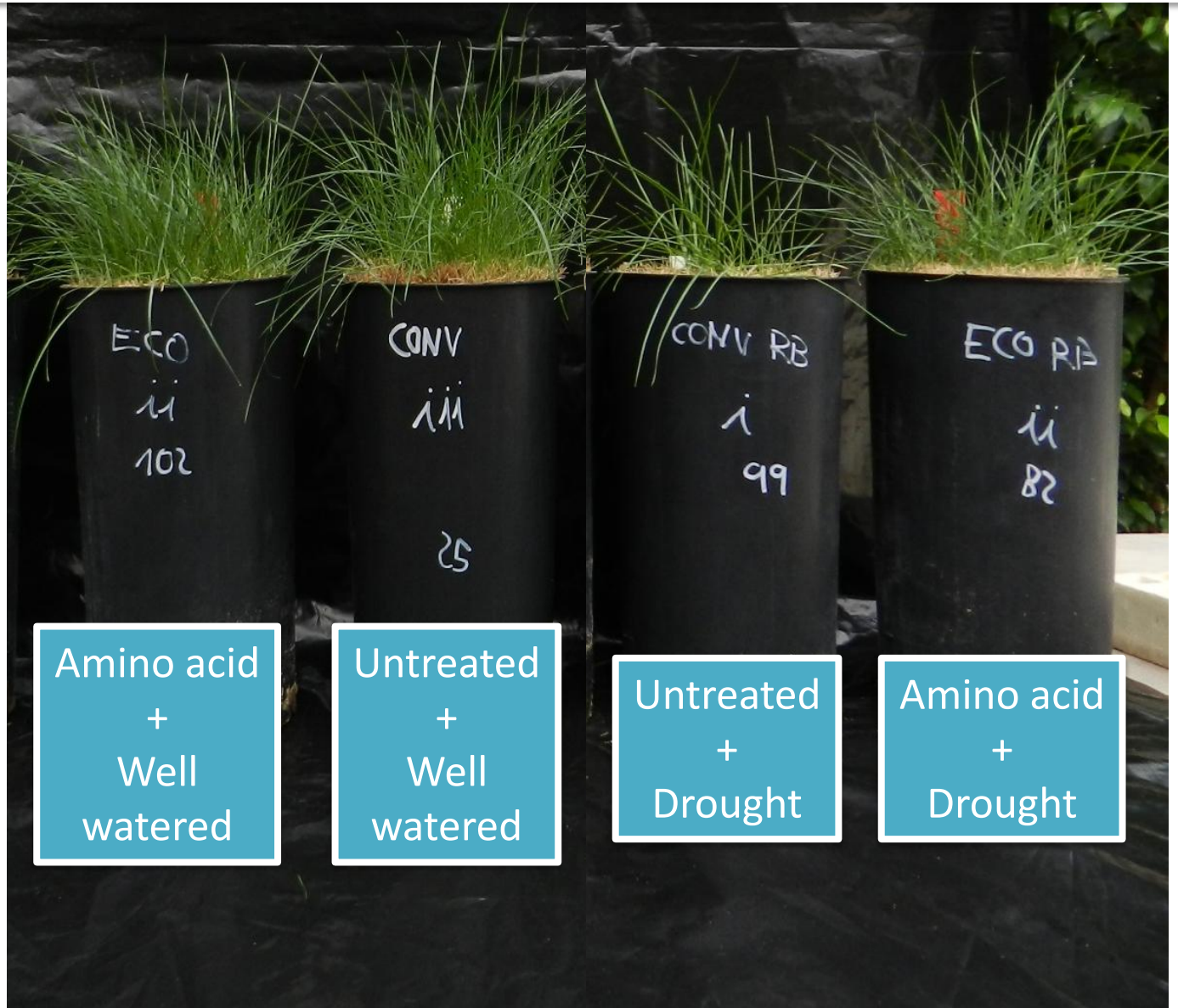
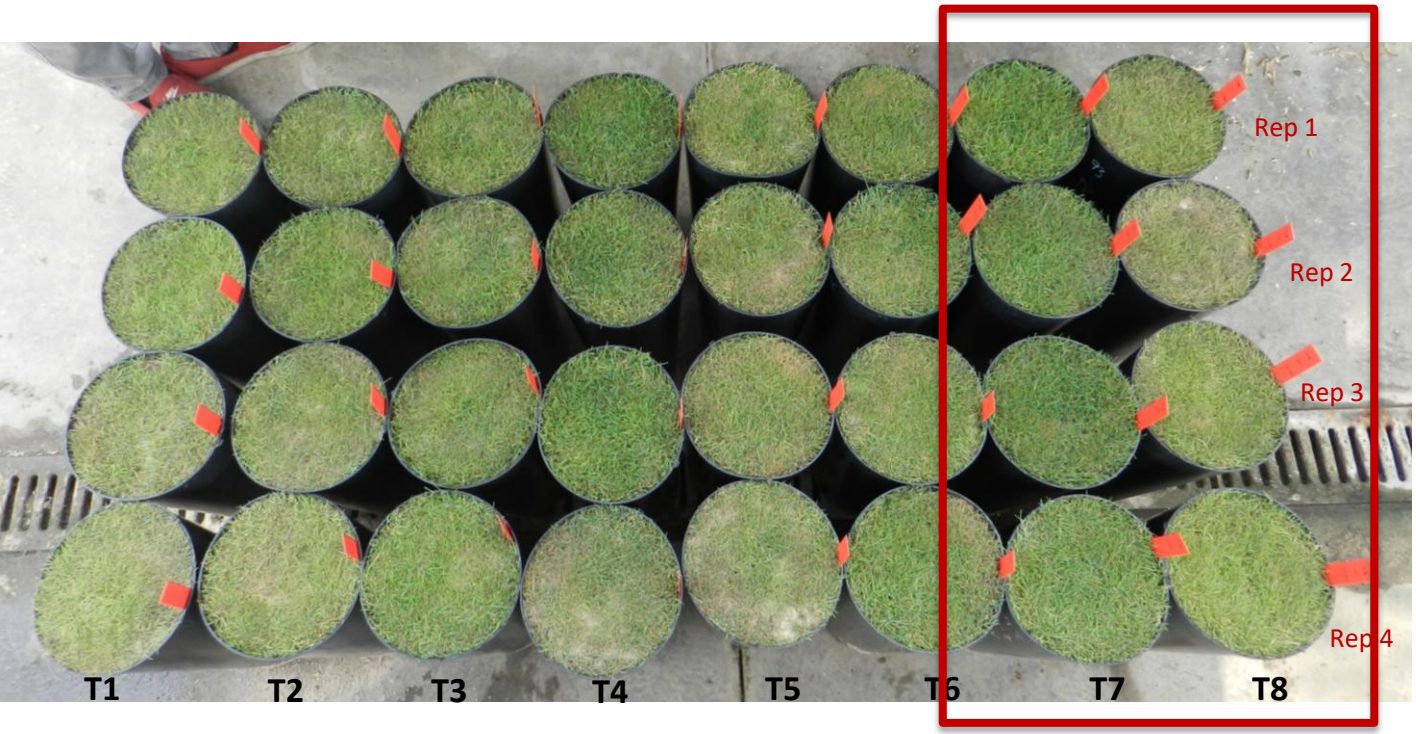

1 month after second (and last) amino acid application
11-June-2014
AMINO ACIDS
Well watered
Drought
UNTREATED

End of the experiment (4th October 2014)
5 months after second (and last) amino acid application
5.5 months under drought conditions



Amino acids for creeping bentgrass under drought stress

PREVENTATIVE + CURATIVE



	L/ha	Interval (days)
T1	Untreated	No Biostimulant. No stress
T2	5	14
T3	10	14
T4	25	14
T5	10	28
T6	20	28
T7	50	28
T8	Untreated + stress	No biostimulant. Stress

- Data: 5th may, 2017
- Number of applications → 5 (14-day interval)
  2 (28-day interval)

Amino acids for Bermudagrass under drought stress

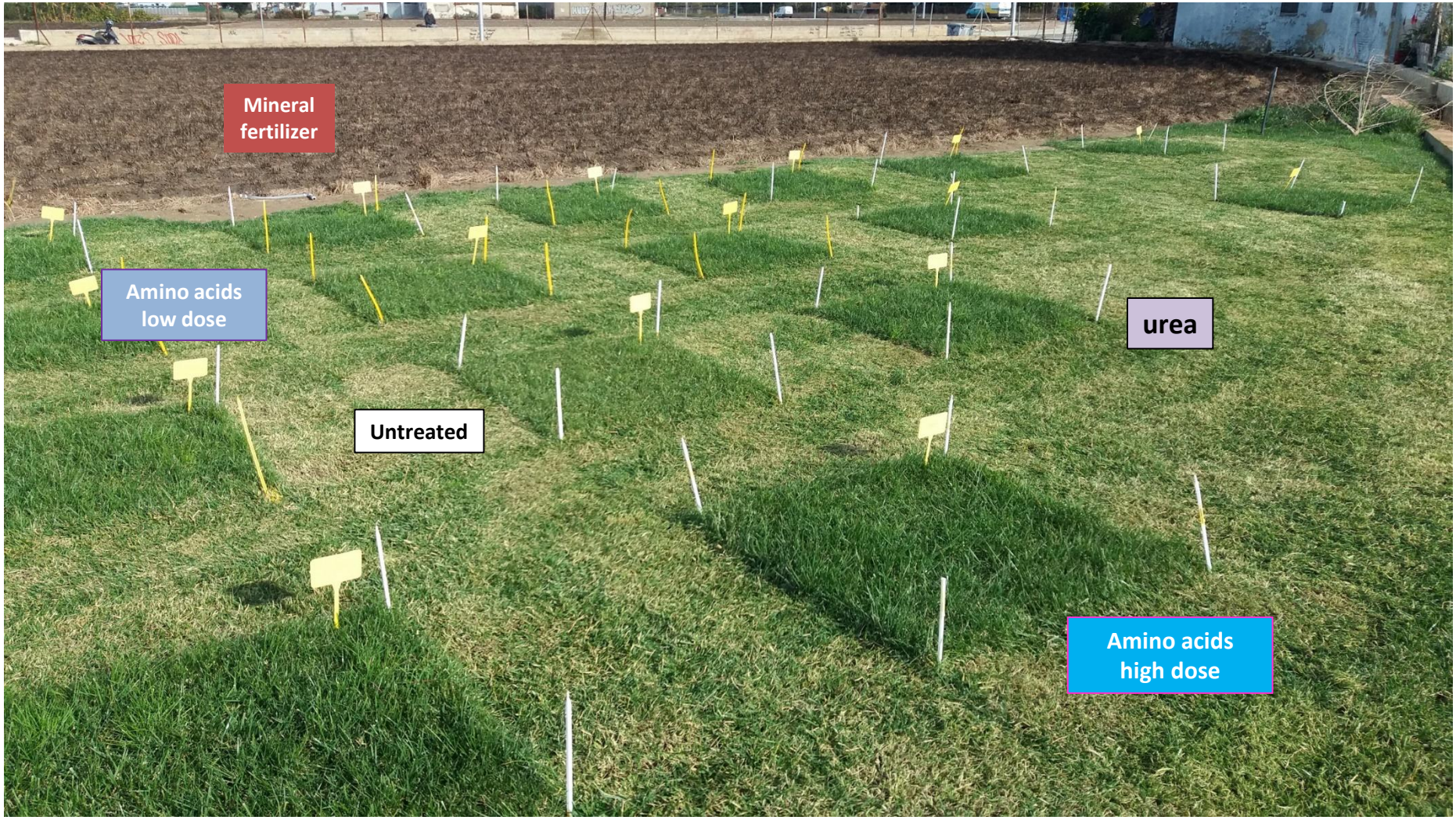
under cold stress

23 June
1 week after second application (weekly appl.)
2 weeks after first application (biweekly appl.)

Amino acids: black
Untreated: white

Amino acids on tall fescue under nutritional stress

Amino acid and urea: 9 applications
Mineral fertilizer: 5 applications



Microbial biostimulants for biotic stress

Conclusions

Biostimulants for drought stress

1.- They are useful, even for severe drought stress, but normally for short stress duration periods.

2.- Pre-stress treatments are neccesary.

3.- They are afordable for high standard turfgrass areas (golf greens or football pitches)

Conclusions

Biostimulants for drought stress

4.- Research has focused on biochemical issues but more research is needed on agronomic practices as well:

* Foliar absoption.
* Root uptake.
* Soil interaction
* Other species/cultivars.
* Application programmes.
* Role of micronutrients in mixtures.

5.- Research is still at pot-greenhouse level, very few field studies.

Thank you for your attention ¡¡¡¡

and especial thanks to:

* Biotecnología del Mediterraneo SL, Bioibérica and Syngenta SPS for providing biostimulants.

* Semillas Dalmau for providing seeds

* Syngenta SPS company for last 5 years of collaboration

* José Manuel Iserte (Head Greenkeeper at Manises Royal Golf Club) for advise, and field plot management.

* ETS board.