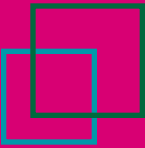


Delfan[®] Plus



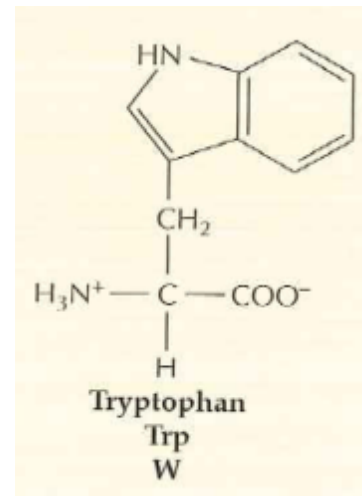
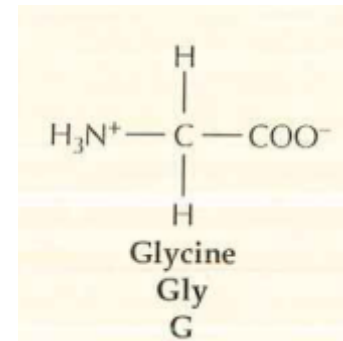
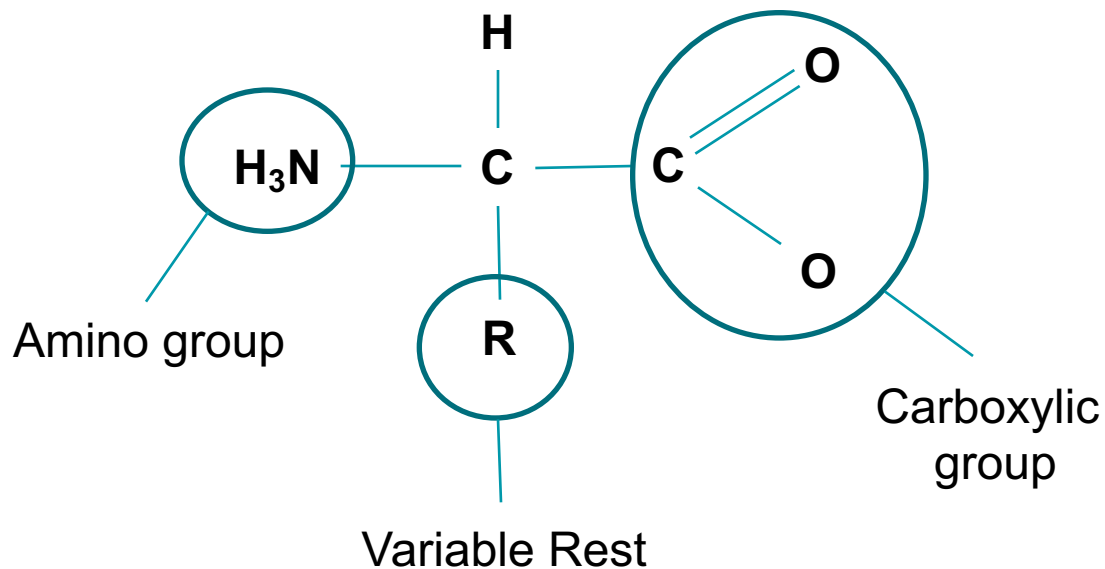


1. Facts about amino acids
2. Delfan vs. vegetal amino acids
3. Functions of amino acids – hormone precursors
4. Delfan Plus and plant stress
5. Surfactant action of Delfan – foliar and root application

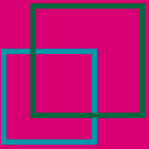


What are amino acids?

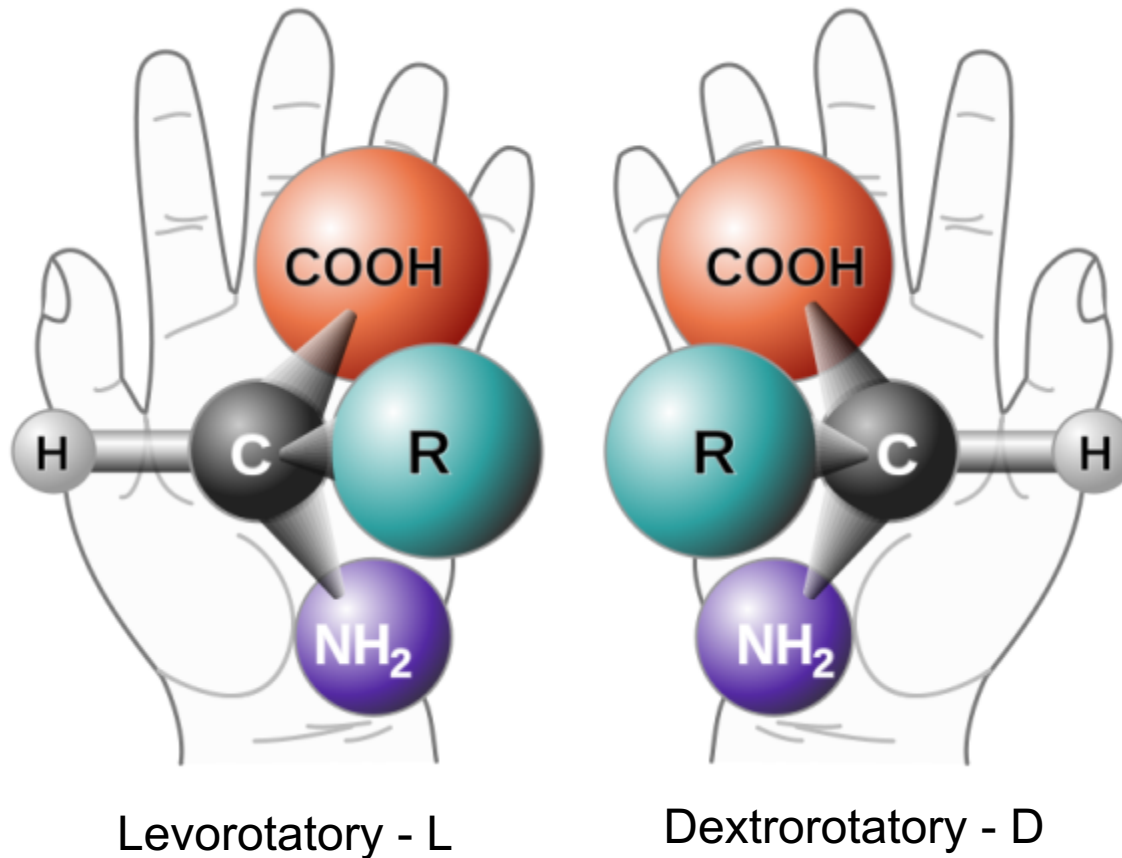
Organic molecules with an amino group and a carboxylic group



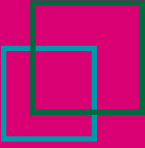
L or D – amino acids. What's the difference?



All amino acids except Glycine exist as two enantiomers or mirror images



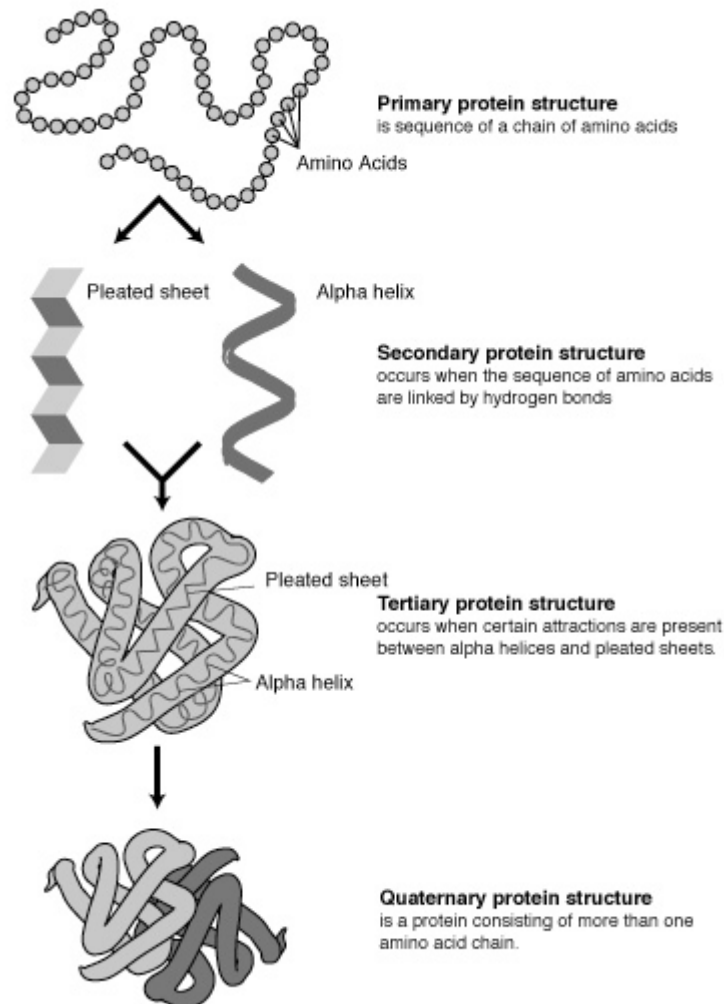
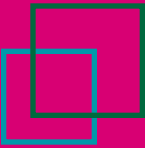
L – amino acids. The natural form



- The only amino acids with biological activity are the L forms.
- D – amino acids do not fit into the protein structures – in the same way as you can't shake hands with your left.
- D – amino acids can be found in products based on synthetic amino acids and amino acids from bacterial production



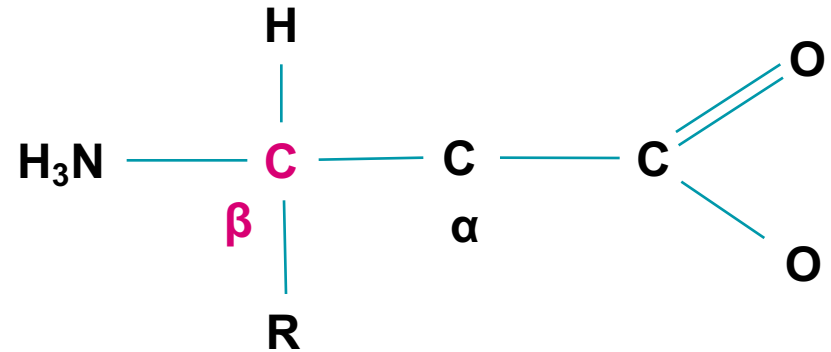
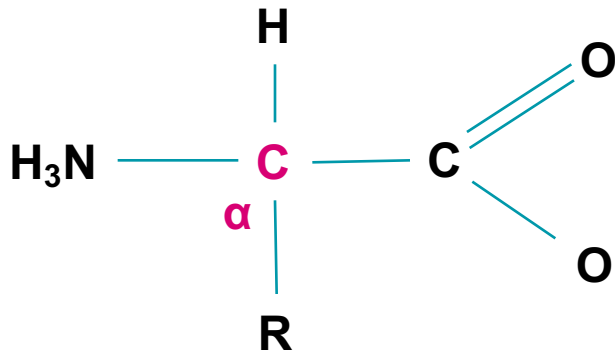
Assembly of plant proteins



- ❖ Proteins consist of amino acids that are bound together in a long chain called peptides
- ❖ From peptides proteins are assembled
- ❖ Proteins are folded in a special way – tertiary protein structure



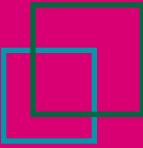
α and β – amino acids



- ❖ α – amino acids have their amino group on the first C atom, β amino acids contain their amino group on the following C atom
- ❖ Delfan Plus contains only α – amino acids



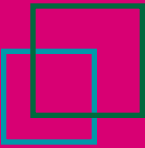
L - α – amino acids



- All amino acids contain a carboxylic and amino group
- All amino acids except glycine form mirror molecules (L and D)
- α , β , and γ -amino acids carry the amino group on different C atoms
- Only the L- α -amino acids are biologically active
- Delfan and Delfan Plus contain only L- α -amino acids

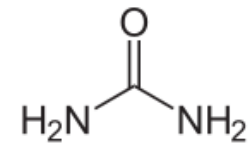


Amino acids compared to other N sources

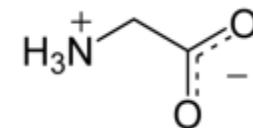


Why should I apply amino acids if plants can synthesize them from N sources?

- Energy saving during stress conditions
- Faster response
- Easy uptake and translocation
- Provides amino acids independently from activity of biological pathways
- Biostimulating action and stress reduction
- Special effects of different amino acids



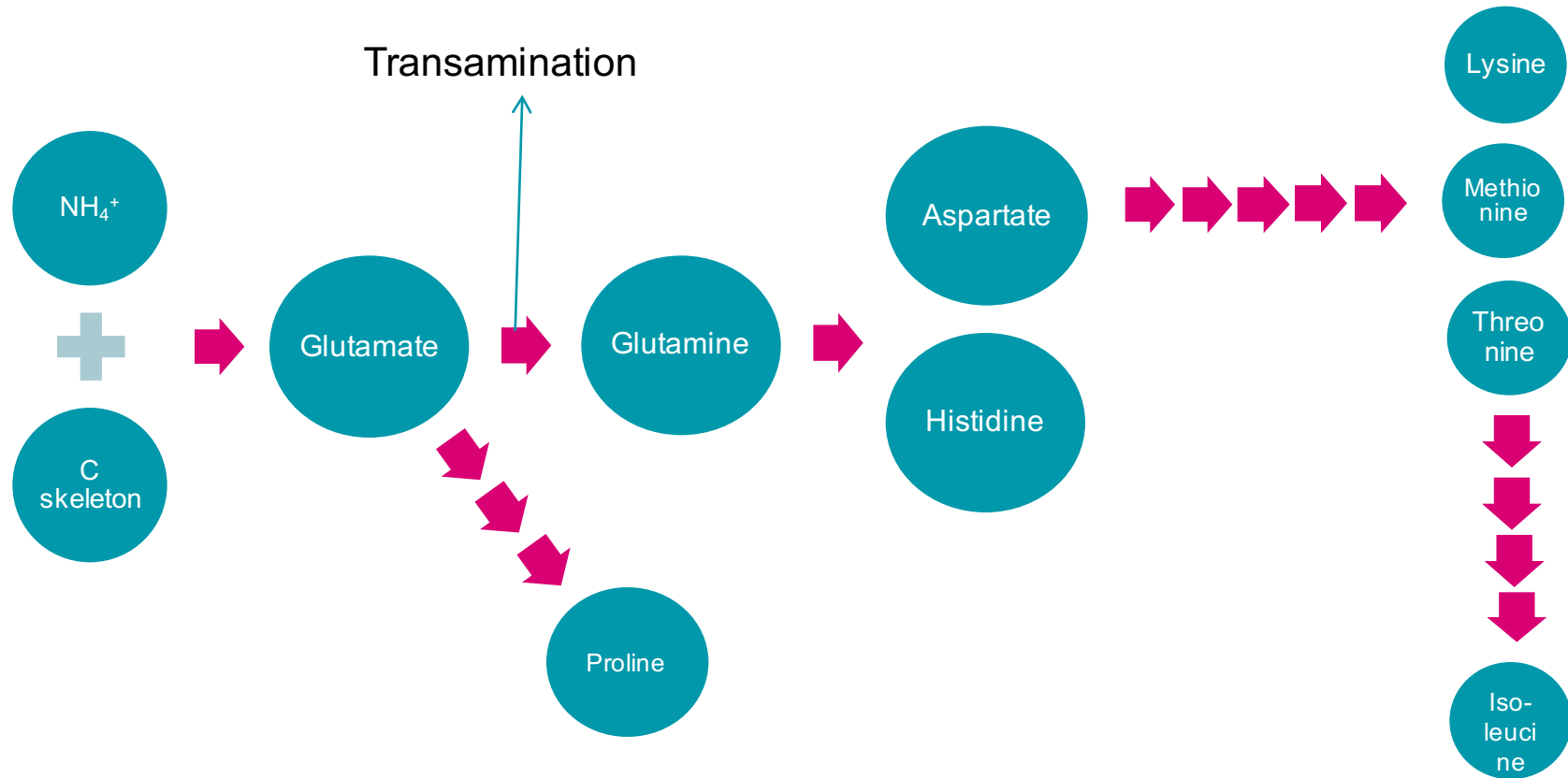
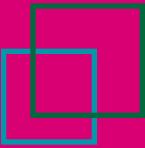
Urea



Glycine



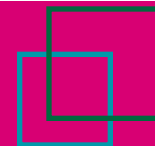
Energy consumption of amino acid production



➡ Energy consuming processes



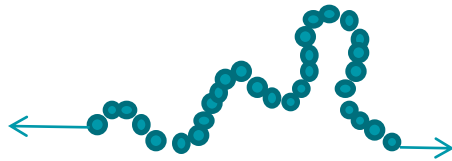
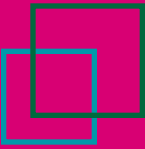
Quality aspects of products containing amino acids



1. Content of free amino acids
2. Extraction method
3. Digestion - Ratio total to free amino acids
4. Complete aminogram
5. Raw material of extraction
6. Heavy metal content



Delfan extraction - Acid hydrolysis



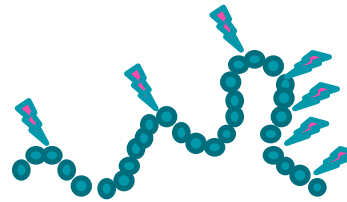
Protein chain



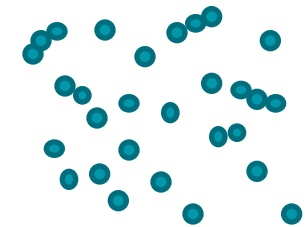
DNA strand



Acid
extractant



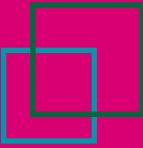
Acid hydrolysis
Braking up of
peptide bonds



Free amino
acids and small
peptides



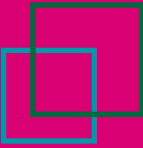
Definitions



- **Free amino acids** – content of amino acids that can be used fast by the plant
- **Total amino acids** – content of free and peptide amino acids. Only part of the total amino acids can be used
- **Peptides** - short amino acid strains with two or more amino acids
- **Proteins** - long chains of amino acids folded in a special way. Proteins have important functions in plant metabolism



Delfan Plus – technical specifications



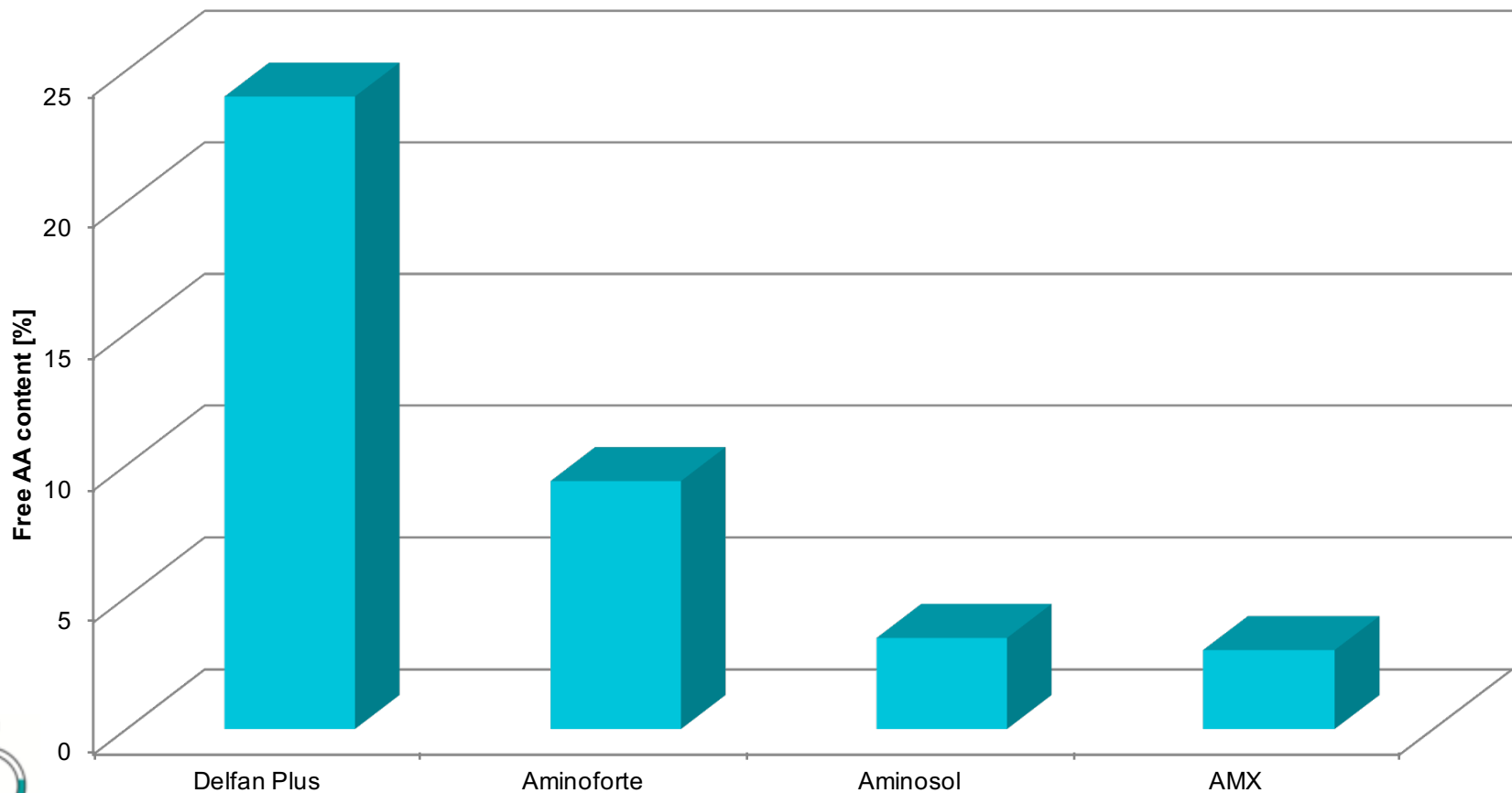
PHYSICAL-CHEMICAL CHARACTERISTICS		
Aspect:	Liquid	
Colour:	Brown	
Density:	1,2 g/cc	
pH:	7,2	
CHEMICAL ANALYSIS		
Parameter	Guaranteed value (% w/w)	Admitted deviation*
Free aminoacids**	24,00%	-1,20
Total nitrogen (N)	9,00%	-0,90
Organic matter	37,00%	-3,00
Organic carbon	23,00%	-2,00

Delfan Plus is extremely high concentrated in free amino acids, **24%**. Products based on enzymatic hydrolysis have a lower content of free amino acids

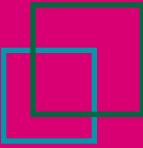


Free amino acid content of Delfan Plus vs. competitors

Free AA content of selected protein hydrolysates



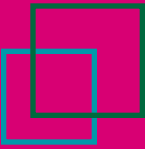
How are amino acids measured?



- HPLC measurements
- Seperate patron for each amino acid
- Measurements of L- α -amino acids
- Specialized lab in Spain
- Standard analysis of each batch



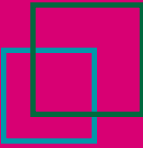
Quality aspects of products containing amino acids



1. Content of free amino acids
2. Extraction method
3. Digestion
4. Complete aminogram
5. Raw material of extraction
6. Heavy metal content



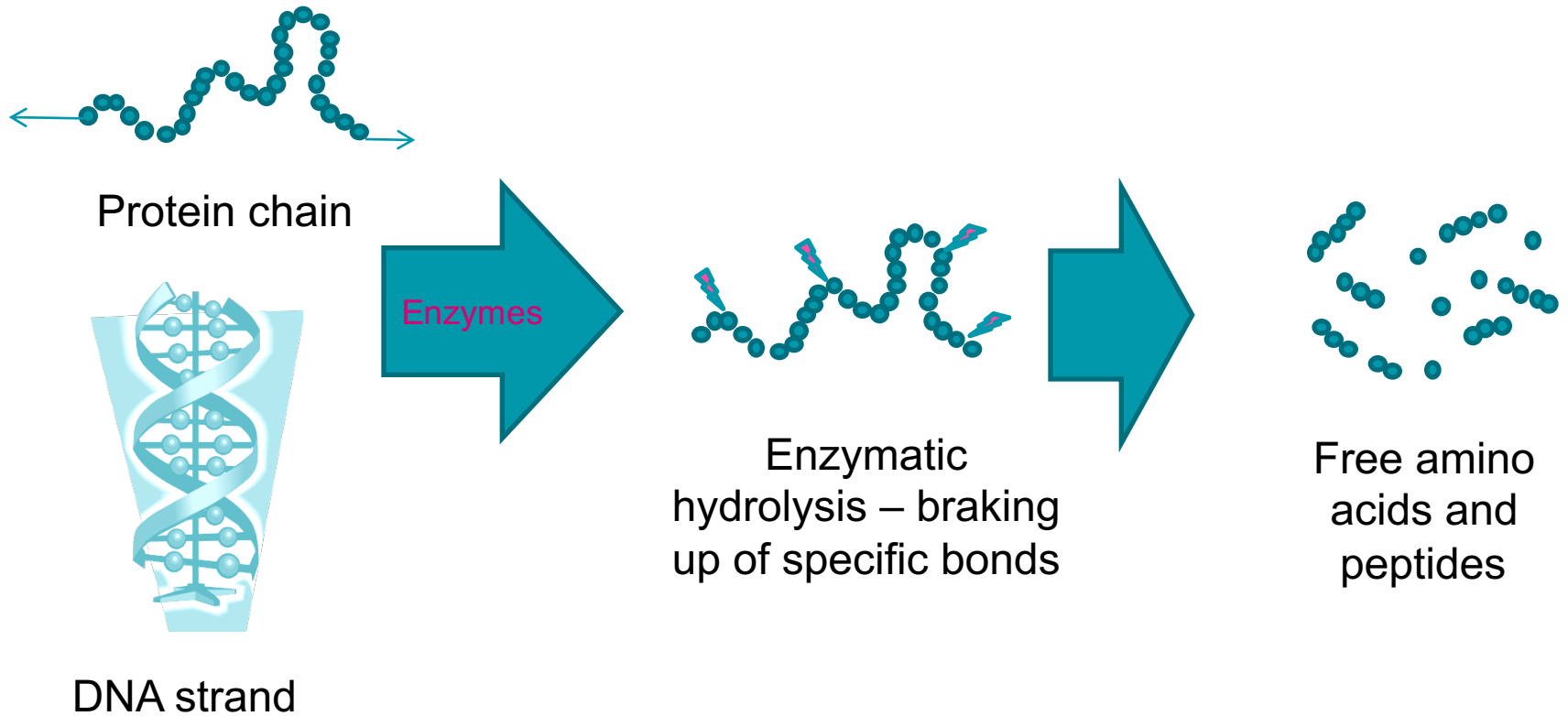
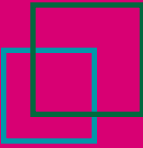
Origins of amino acids



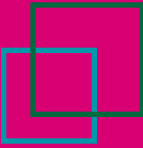
- Amino acids from acid hydrolysis
- Amino acids from enzymatic hydrolysis
- Synthetic amino acids from bacterial production
- Synthetic amino acids from synthesis



Enzymatic hydrolysis - what's the difference?



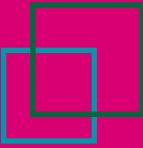
Comparison extraction processes



Enzymatic hydrolysis	Acid hydrolysis
Enzymes	Acid extractant
specific peptide bonds are broken	Unspecific breaking of peptide bonds
Digestion incomplete	More complete digestion
Lower content of free amino acids	Higher content of free amino acids
Higher peptide content	Smaller peptide size and less peptide content
More difficult uptake and efficiency	Good uptake and efficiency



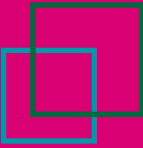
Quality aspects of products containing amino acids



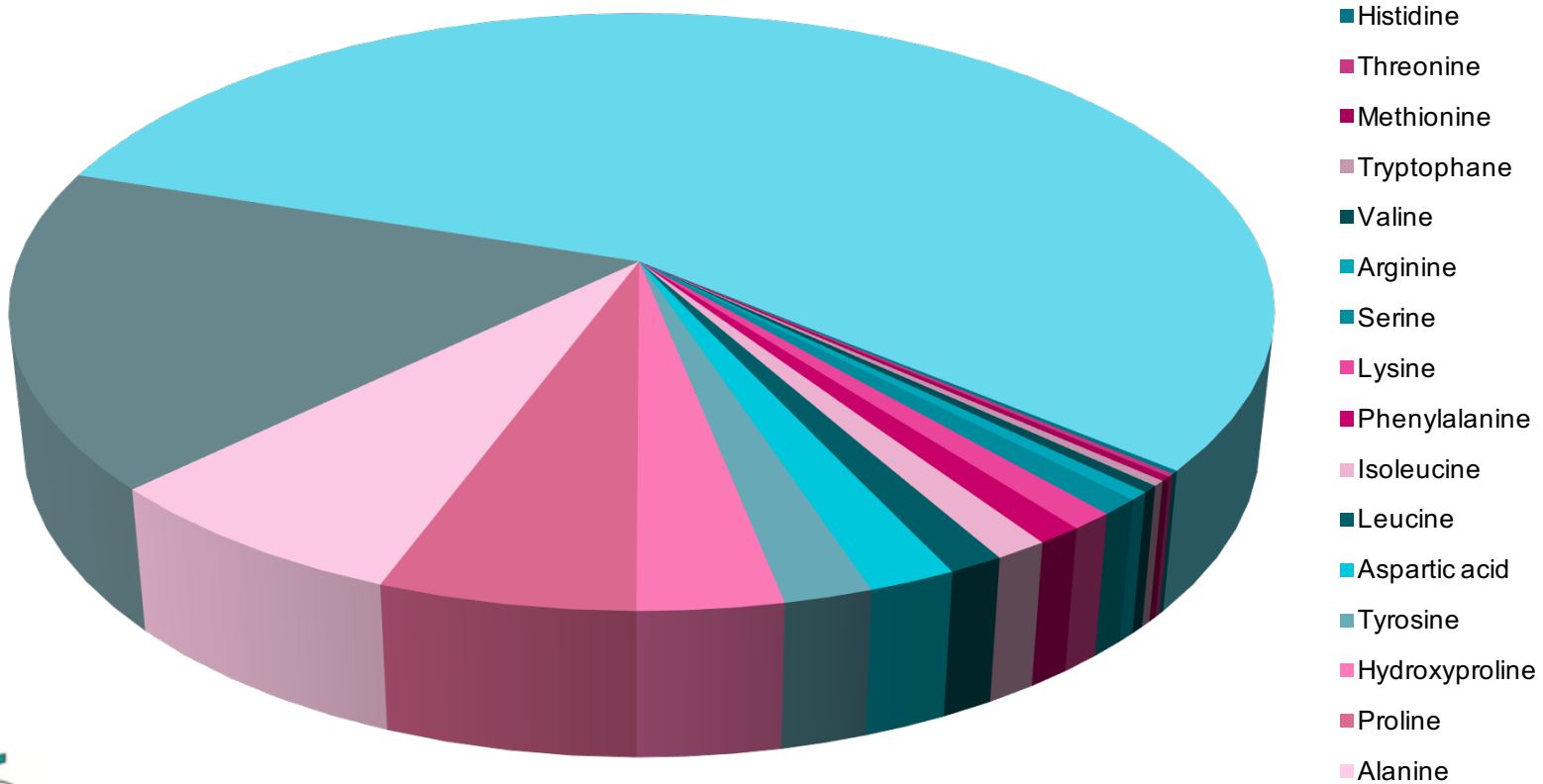
1. Content of free amino acids
2. Extraction method
3. Digestion - Ratio total to free amino acids
4. Complete aminogram
5. Raw material of extraction
6. Heavy metal content



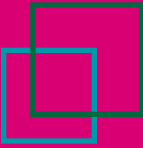
The importance of the aminogram



Delfan Plus aminogram



Why is a complete aminogram important?



The ideal situation would be to apply exactly the types of amino acids a plant needs in a precise moment. Of course that's not possible.

As an alternative a good product based on amino acids should contain:

- ✓ A high amount of functional amino acids
- ✓ A high amount of an amino acid that is easy to transaminate



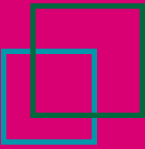
Highest possible physiological action

Easily adaptable aminogram

Broad spectrum of efficiency



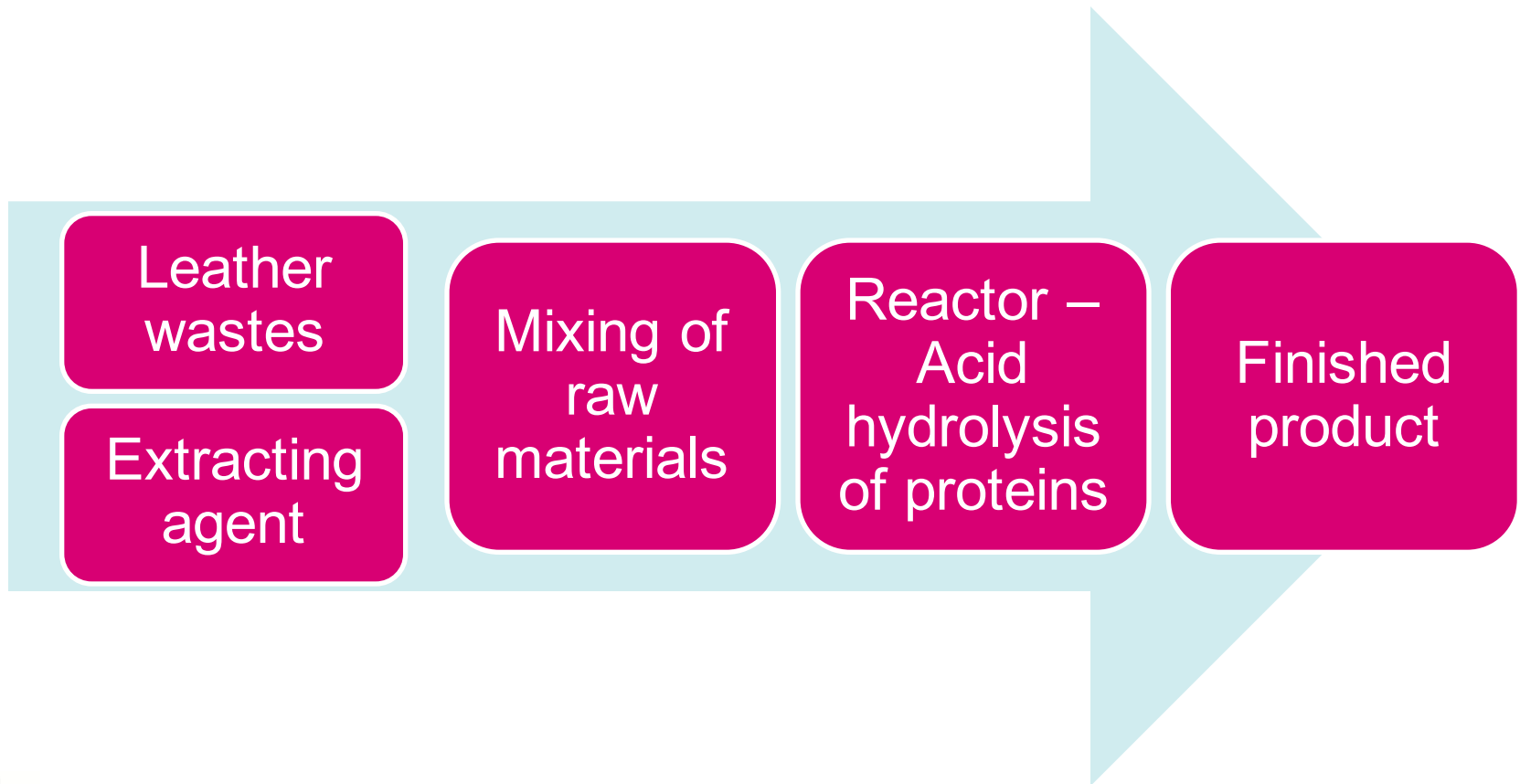
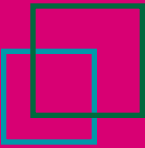
Quality aspects of products containing amino acids



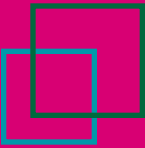
1. Content of free amino acids
2. Extraction method
3. Digestion - Ratio total to free amino acids
4. Complete aminogram
5. Raw material of extraction
6. Heavy metal content



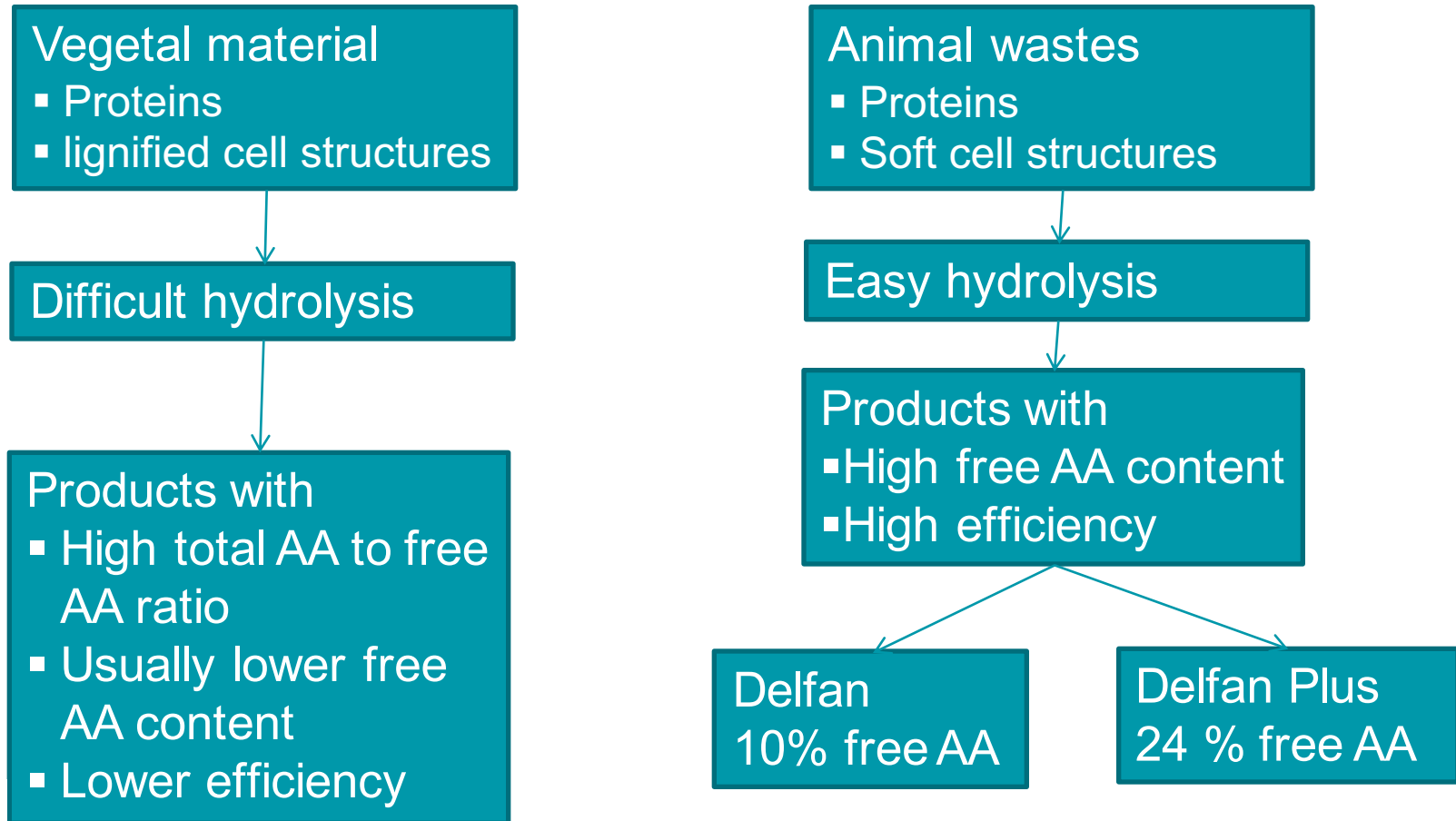
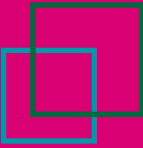
Flow chart of production process



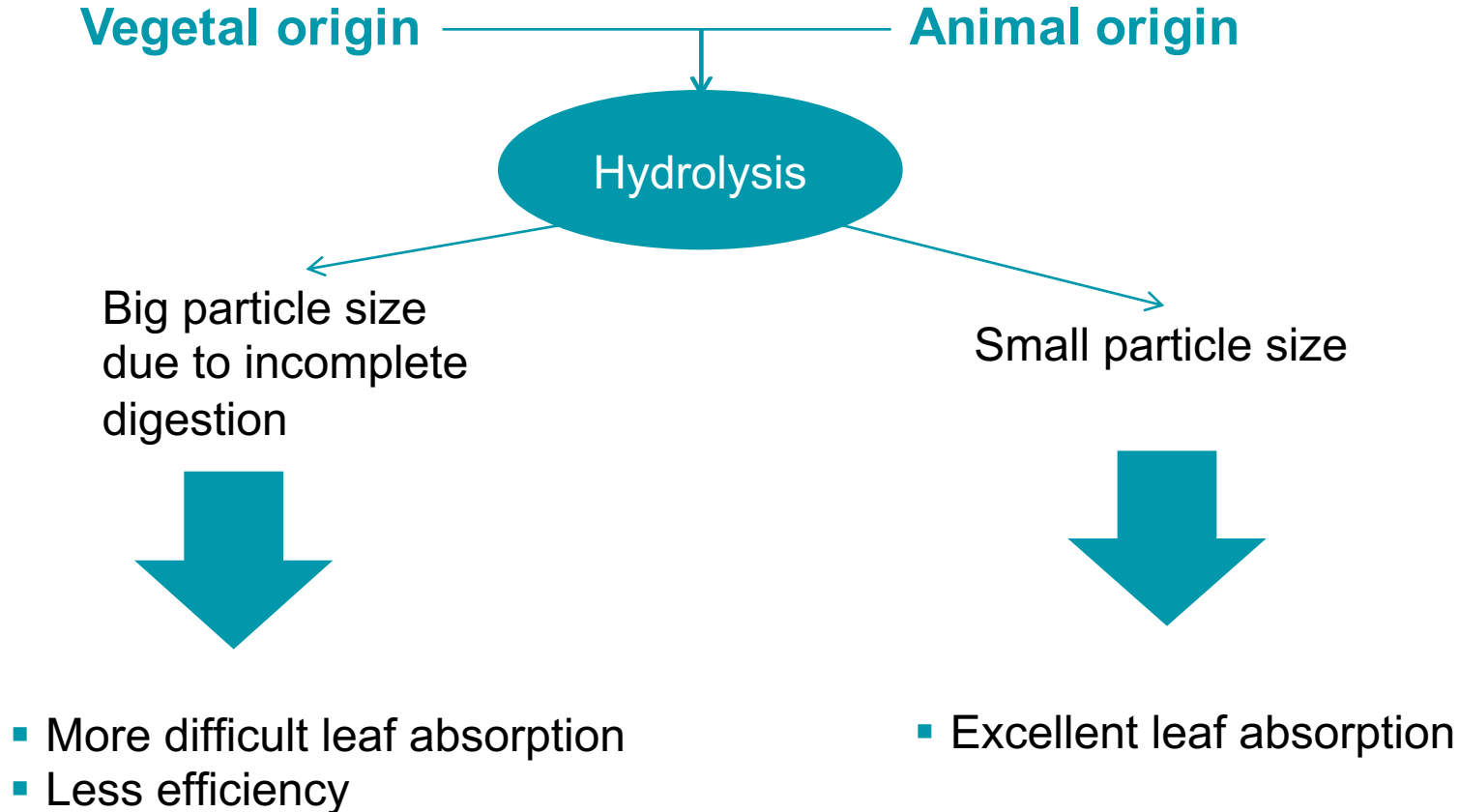
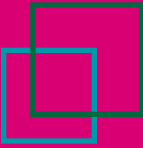
Delfan vs vegetal AA



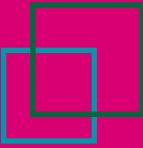
AA origins – what's the difference?



Digestion of Amino Acids



Raw material and costs



Vegetal origin

Raw material:

- Soybean
- Wheat



- Product price dependent on market price fluctuations
- More expensive product

Animal origin

Raw material:

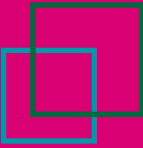
- Leather industry
- Waste material



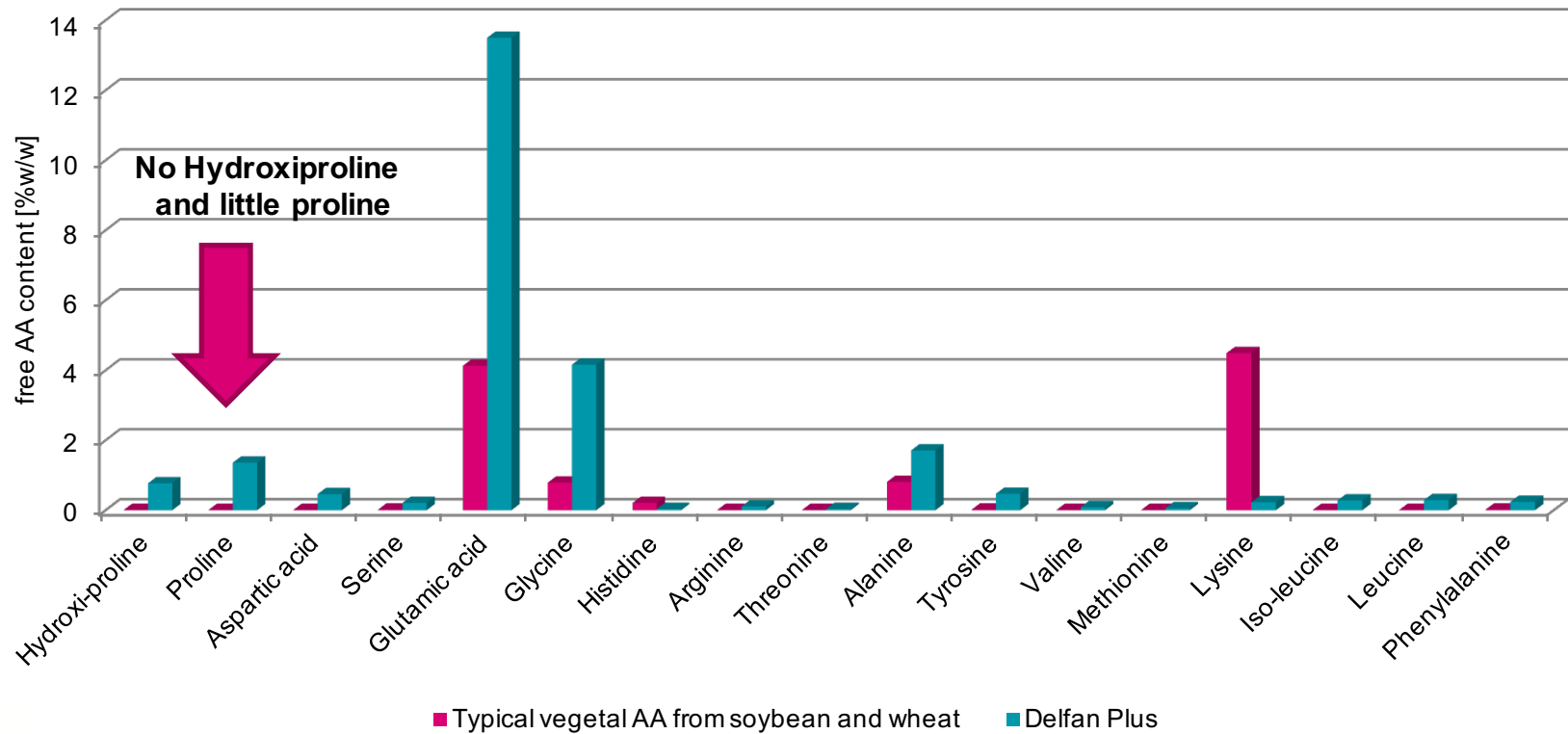
- Raw material waste product
- Independent from market prices



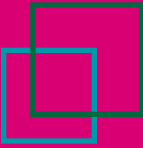
Differences in aminograms



Vegetable aminogram vs. Delfan Plus



The importance of Proline and Hydroxiproline



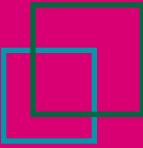
- ❑ Proline is an excellent **anti stress agent** and leads to tolerance to a wide range of abiotic stresses
- ❑ Proline is especially important during osmotic stress (drought, salinity and freezing)

Proline leads to:

- Osmotic adjustment (**Compatible osmolyte**)
- Stabilized **cellular structures**
- Prevention of cell damage due to free radicals (**Radical Scavenger**)
- Provides energy needed for **recovery**



How to determine the origin



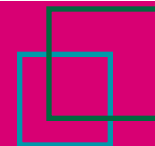
Amino acids from vegetal origin will normally show:

- Higher cost due to raw material prices
- Higher relation total to free aminoacids
- Lower concentration (Maximum 18% free AA – origin yeast)
- No Hydroxi-proline and lower Proline inside
- Less efficacy

Determination by PCR analysis possible but extremely expensive

If one or more of these aspects are not true we are most probably dealing with aminoacids from animal origin





Research Center: Besana Consulting

Plantation: 2007

Location: Murcia, Spain

Crop: Lettuce

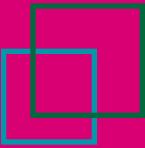
Substrate: Turf – Perlite mixture

Application: Foliar 3x4L/ha, every 10 days

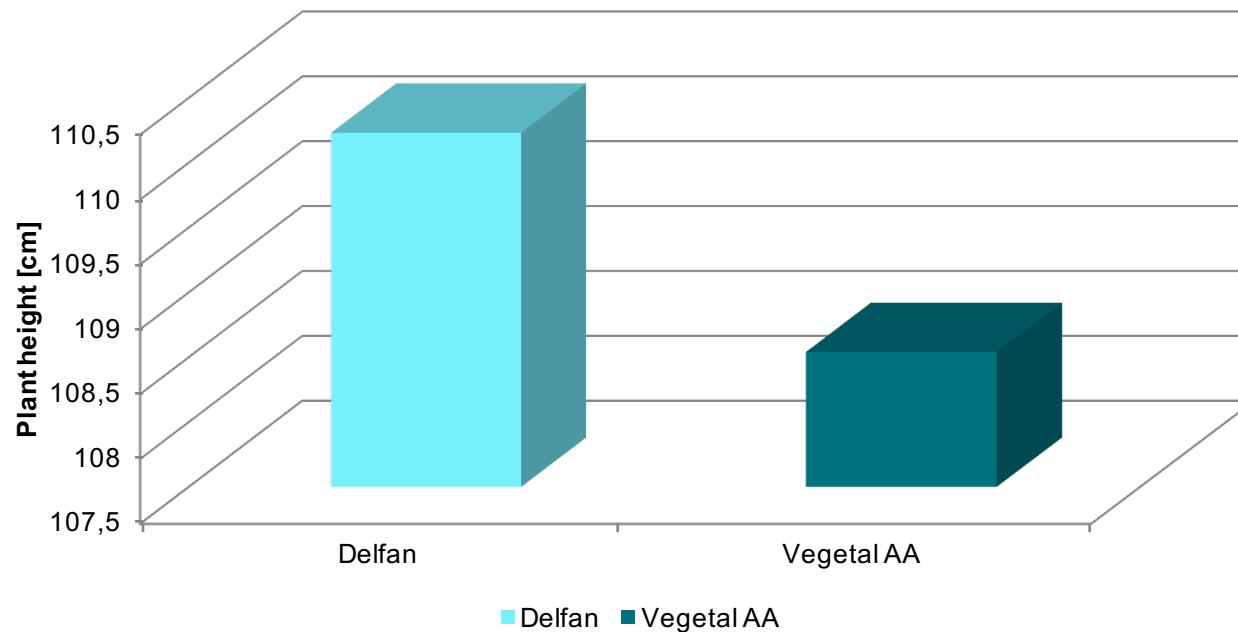
- Comparison of Delfan and vegetal amino acids - the same dose rate of free AA per application.



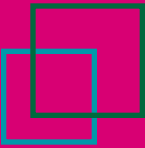
Trial on lettuce plantlets 2007



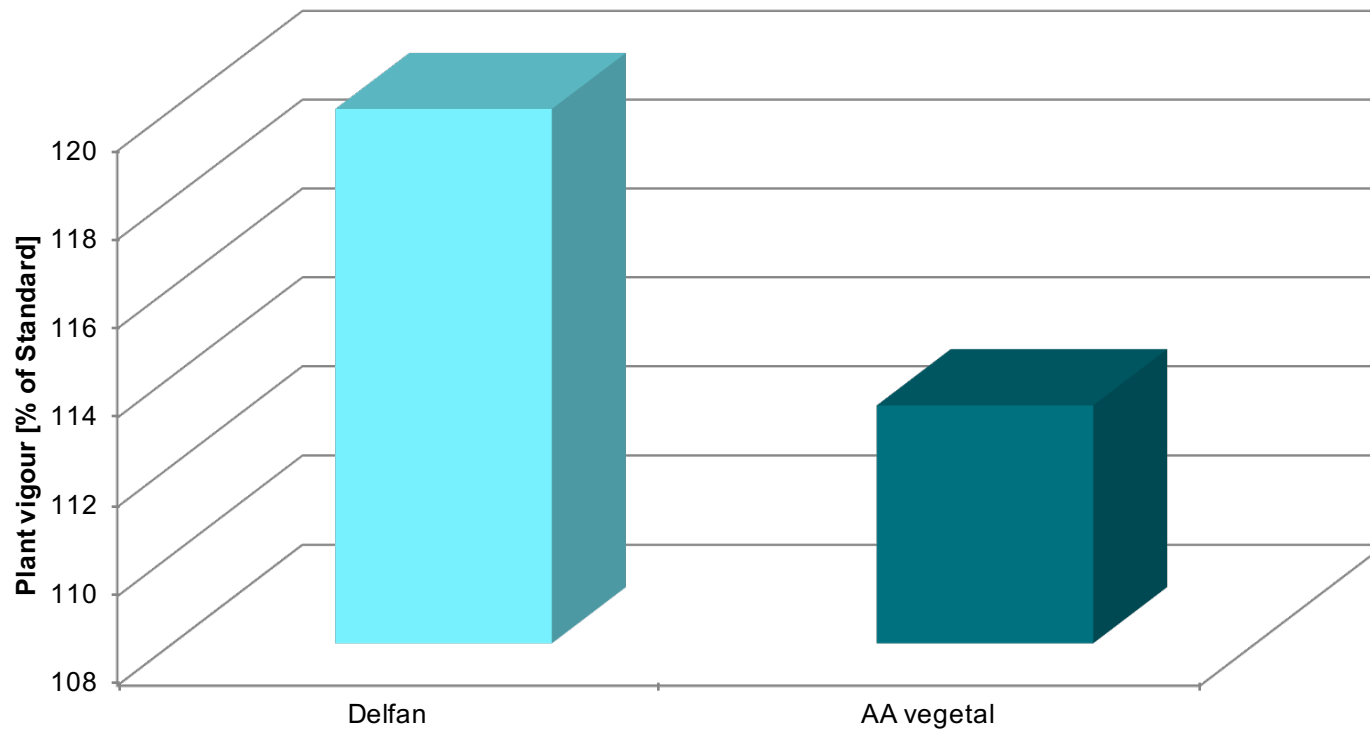
Effect of Delfan compared to veg AA application at the same rate of free AA



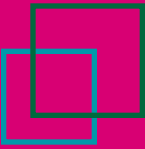
Trial on lettuce plantlets 2007



Plant vigour of lettuce plantlets after applications of Delfan and vegetal AA



Trial on lettuce plantlets 2007



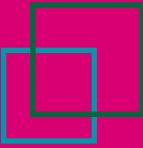
Vegetal AA



Delfan



Trial on lettuce plantlets - Conclusions



- Delfan showed better plant vigour and growth compared to vegetal amino acids
- Delfan is more efficient than vegetal AA



Trial on Peppers in Egypt – Trial conditions

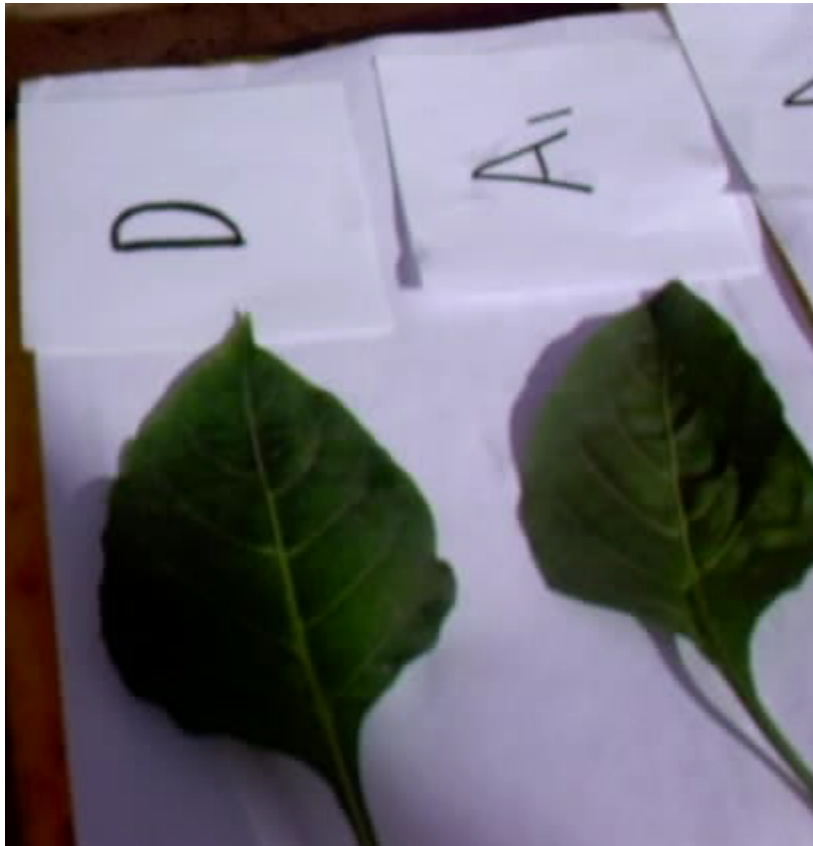
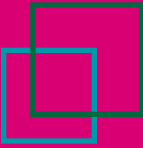


- **Crop:** Sweet Pepper
- **Cycle:** August 2008
- **Variety:** Lamborghini, Enza Zaden
- **Application:** Foliar
- **Objectives:** Compare the effects of Delfan and vegetal AA on growth, yield and quality of sweet pepper

Product	Area	First Application	2nd application
Delfan (D)	35m ² (110 plant)	3cc / Lt of water 1/12/2008	3cc / Lt of water 13 / 12 / 2008
Vegetal AA (A1)	35m ² (110 plant)	3cc / Lt of water 1/12/2008	3cc / Lt of water 13 / 12 / 2008



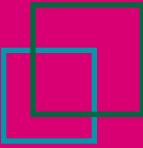
Trial on Peppers in Egypt



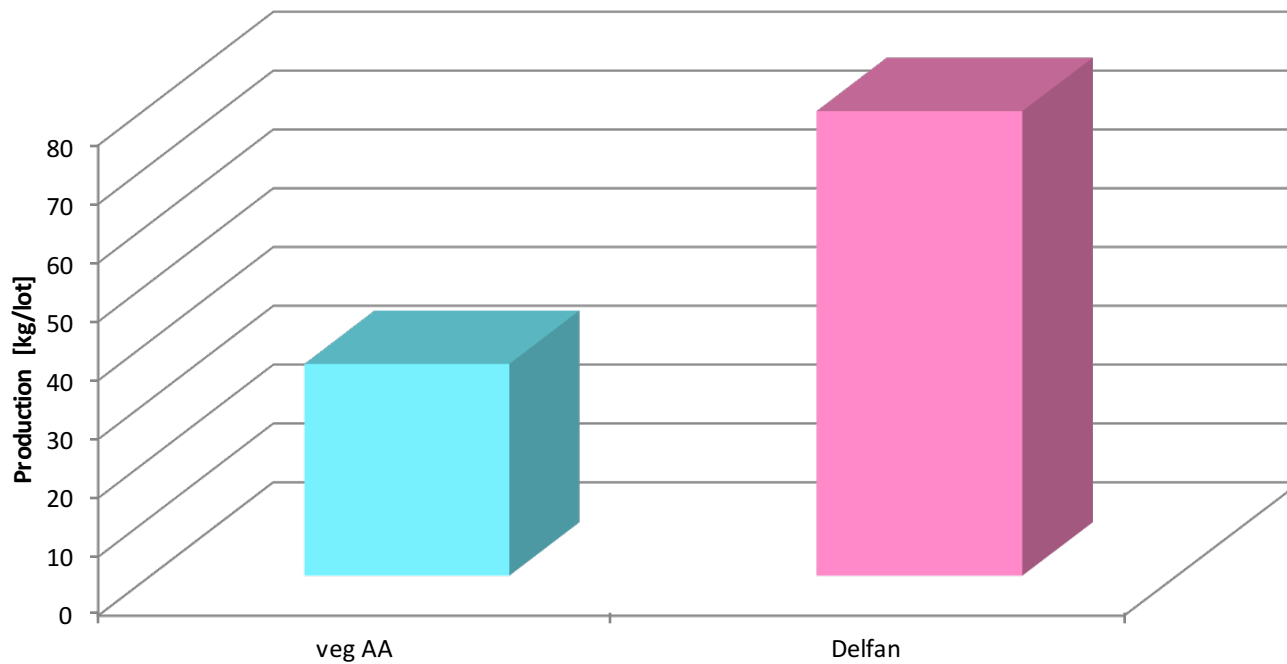
- Comparison of leaf size. On the left Delfan, on the right vegetal
- The leaf area of Delfan is bigger compared to the vegetal AA treatment, which leads to enhances photosynthesis, plant vigour and yield.



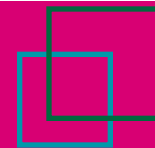
Trial on Peppers in Egypt



Effect of Delfan compared to vegetable AA on Pepper production in Egypt



Trial on Peppers in Egypt

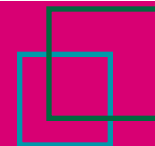


Delfan

Vegetal AA



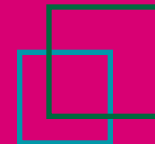
Quality aspects of products containing amino acids



1. Content of free amino acids
2. Extraction method
3. Digestion - Ratio total to free amino acids
4. Complete aminogram
5. Raw material of extraction
6. Heavy metal content



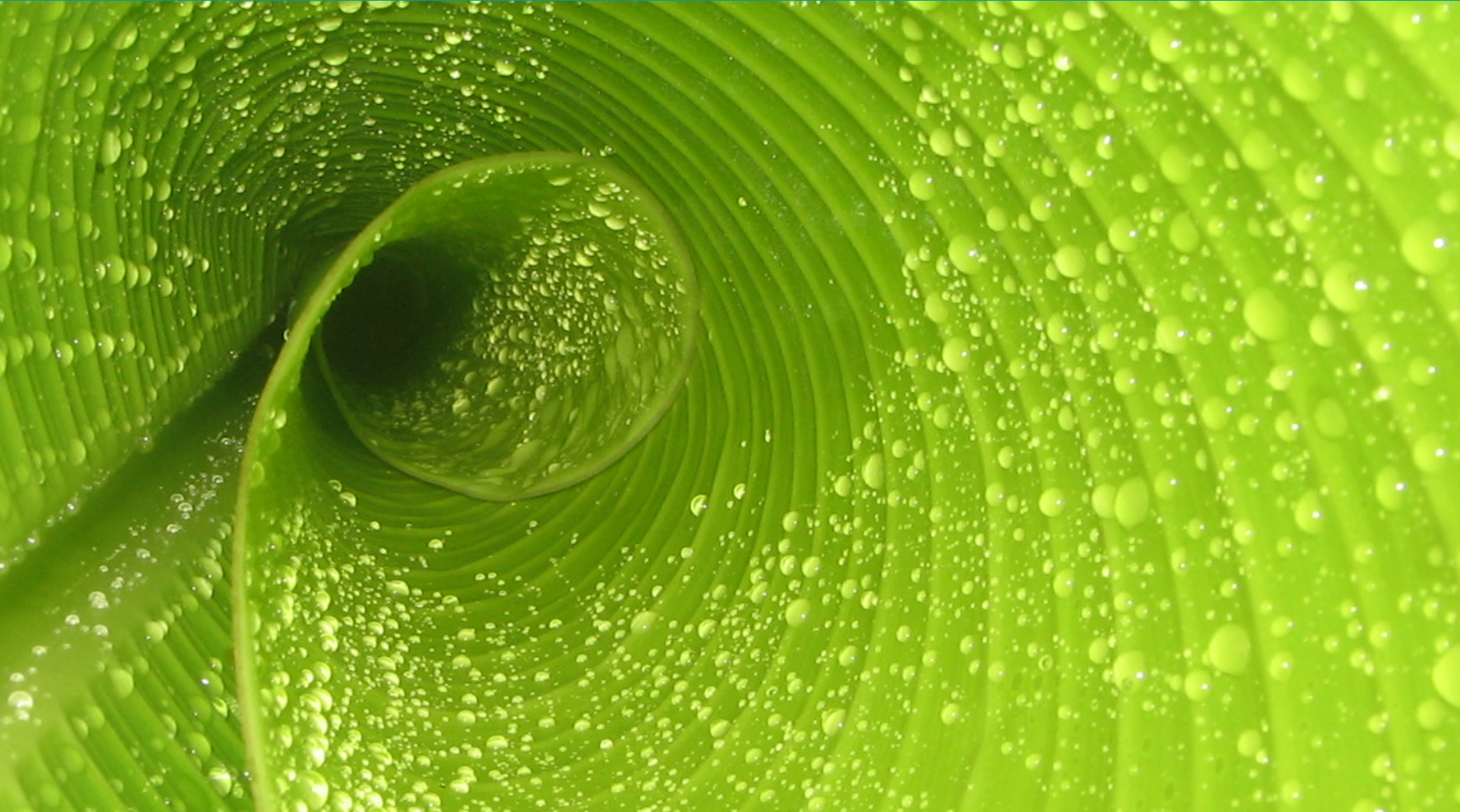
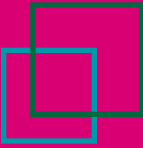
Heavy metal contents of Delfan



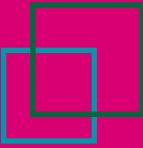
Heavy metal	Concentration [ppm]
Cadmium (Cd)	<0,02
Chrome (Cr)	0,47
Niquel (Ni)	5,46
Lead (Pb)	<0,04
Copper (Cu)	2,05
Zinc (Zn)	0,09
Mercury (Hg)	<0,05



Functions of amino acids

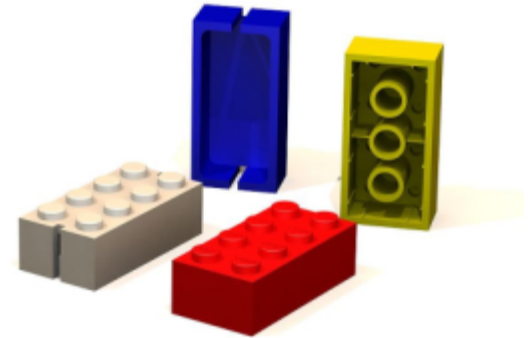


Function of amino acids in plants



Amino acids are the building blocks of life

- Protein synthesis
- DNA synthesis
- Precursors of hormones
- Precursors of other functional molecules
- Stress metabolism



Without amino acids there is no life



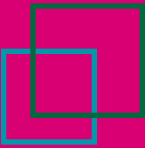
Functions of amino acids



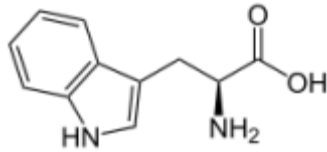
Amino acid	Effect or function
All AA	Protein synthesis
Glycine	DNA synthesis, Alcaloid metabolism
Glutamic acid	Chlorophyll synthesis
Tryptophane	Auxin and phytoalexin precursor
Methionine	Ethylen and polyamine precursor
Aspartate, glutamine and glutamate	N and C storage amino acids, transport amino acids
Proline	stress metabolism, flowering
Serine	Precursor glycine betaine, stress metabolism
Alanine	Precursor of certain antibiotics in some species
Leucine, Lysine, tryptophane, histidine, phenylalanine, tyrosine and glycine	Alcaloid metabolism, plant protection against pests and stress
Phenylalanine	Salicylic acid production, stress and disease prevention
Tyrosine	Glucosinolate precursors “Phytoanticipins”



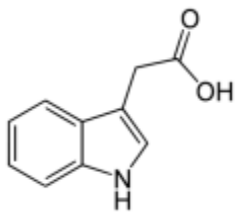
Amino acids as hormone precursors



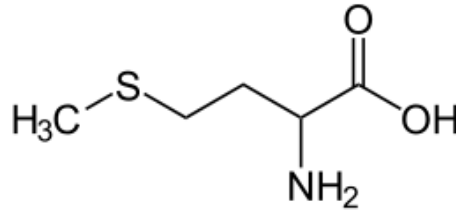
Amino acids as hormone precursors



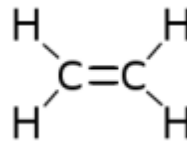
Tryptophane



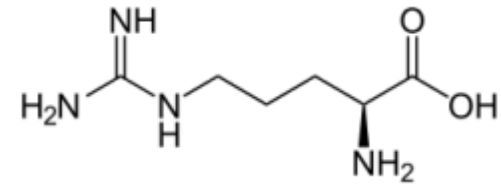
IAA - Auxin



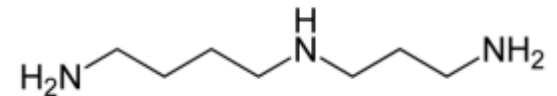
Methionine



Ethylen



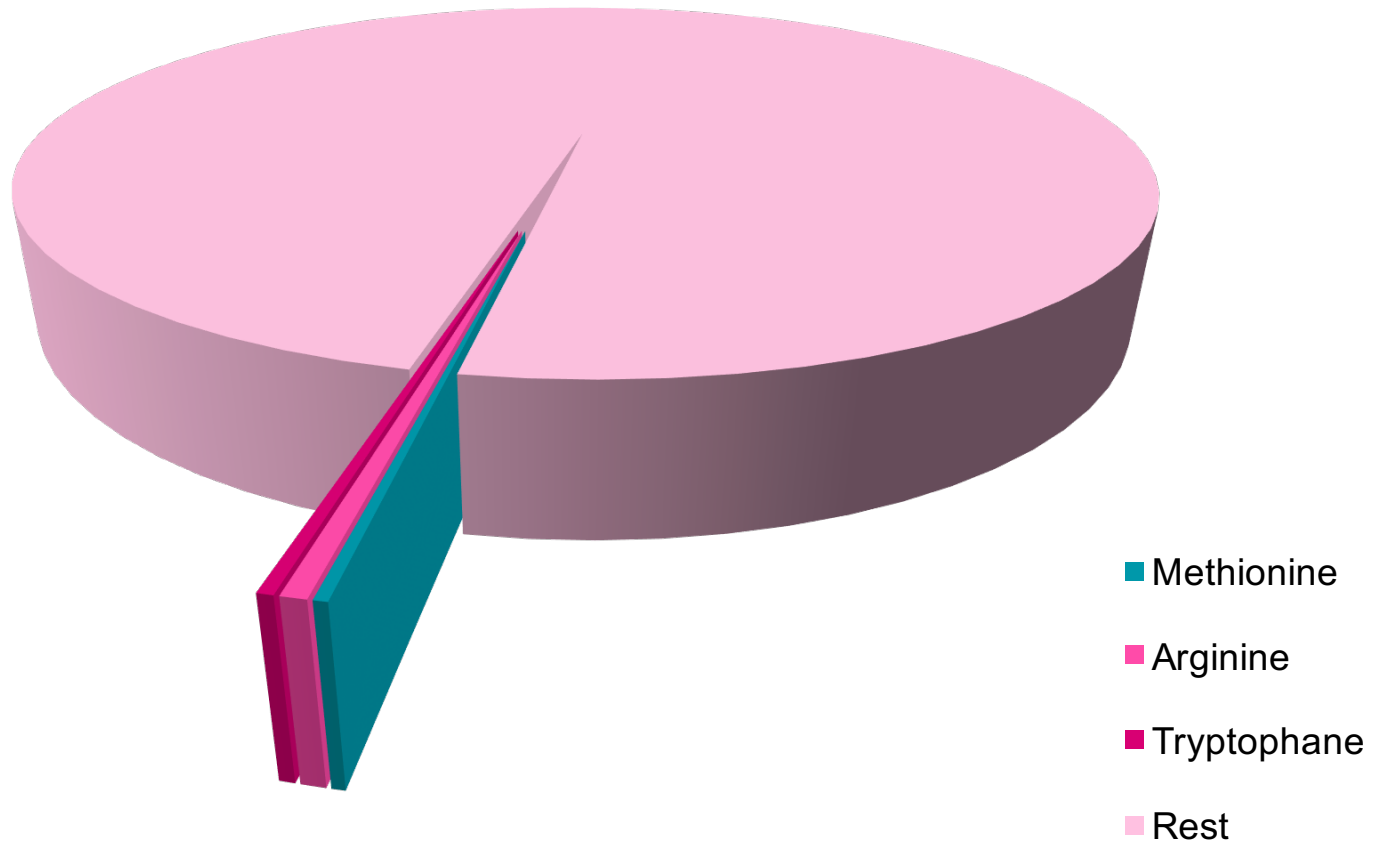
Arginine



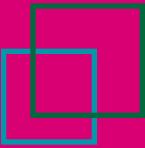
Polyamines



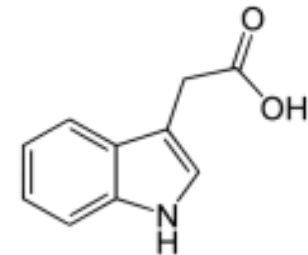
Delfan Plus content of hormone precursor amino acids



Functions of Auxins



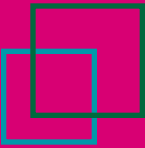
- Root growth and differentiation
- Cell division
- Differentiation of meristematic areas
- Growth of side shoots
- Flower formation
- Tuber formation
- Cell growth
- Stimulation of Ethylene – fruit maturation
- Seed germination



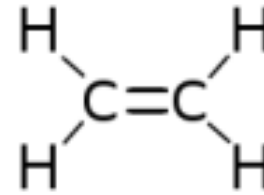
IAA - Auxin



Functions of Ethylene (=Ethen)



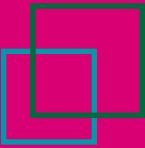
- Fruit ripening
- Flower formation
- Senescence
- Seed germination
- Cell elongation
- ...



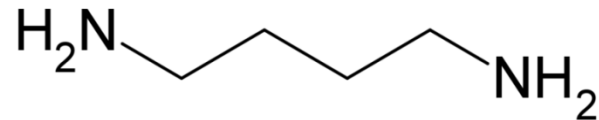
Ethylen



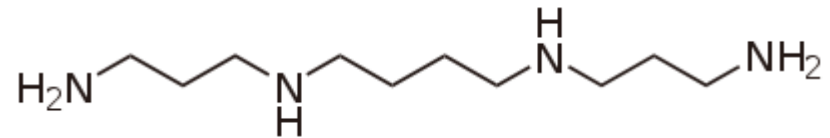
Functions of Polyamines



- Regulation of gene expression
- Cell proliferation
- Membrane stabilization
- Ion transport
- Stress responses



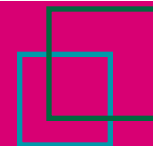
Putrescine



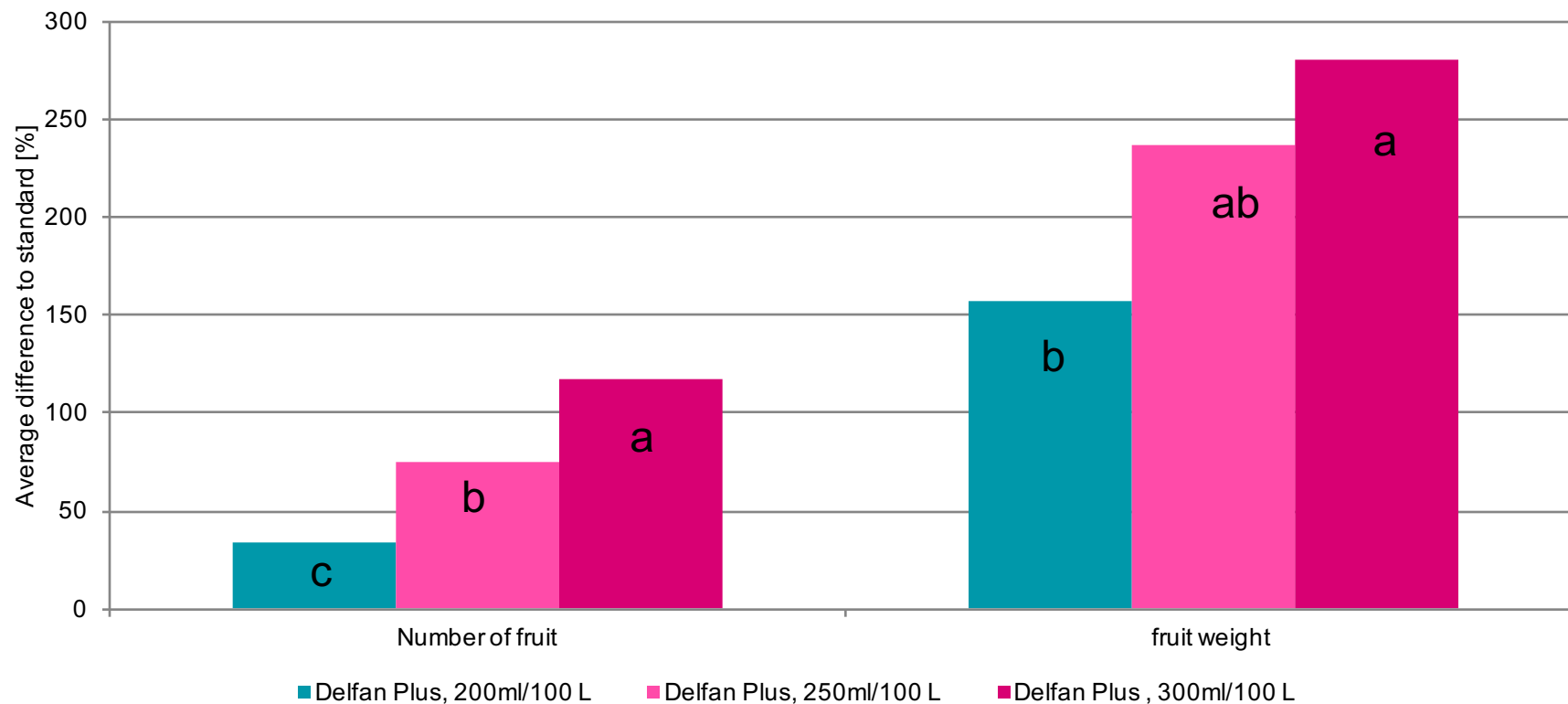
Spermine



Trial on tomato fruit set in Mexico



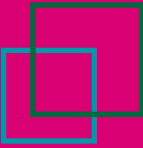
Effect of Defan applications on Tomato fruit set in Mexico



- Trial done in collaboration with the University of Chapinga, Mexico
- Significant differences to the standard without treatment



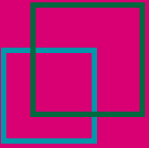
What to expect



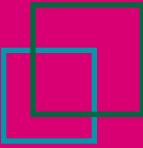
- Faster maturation – enhanced earlyness
- Flower formation
- Side shoot formation
- Seed germination
- Growth stimulation
- Root formation



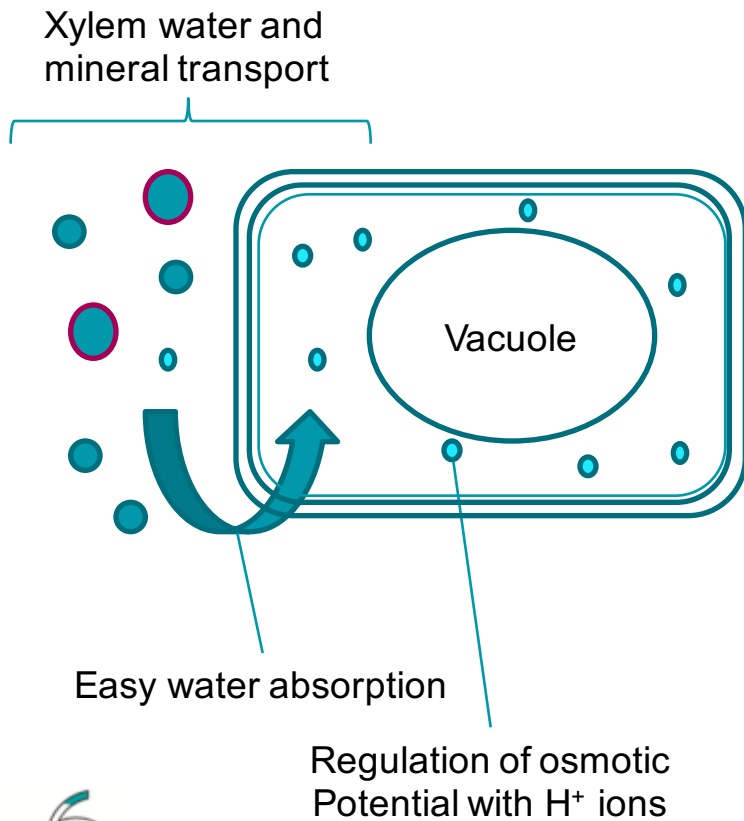
Delfan – Preventing plant stress



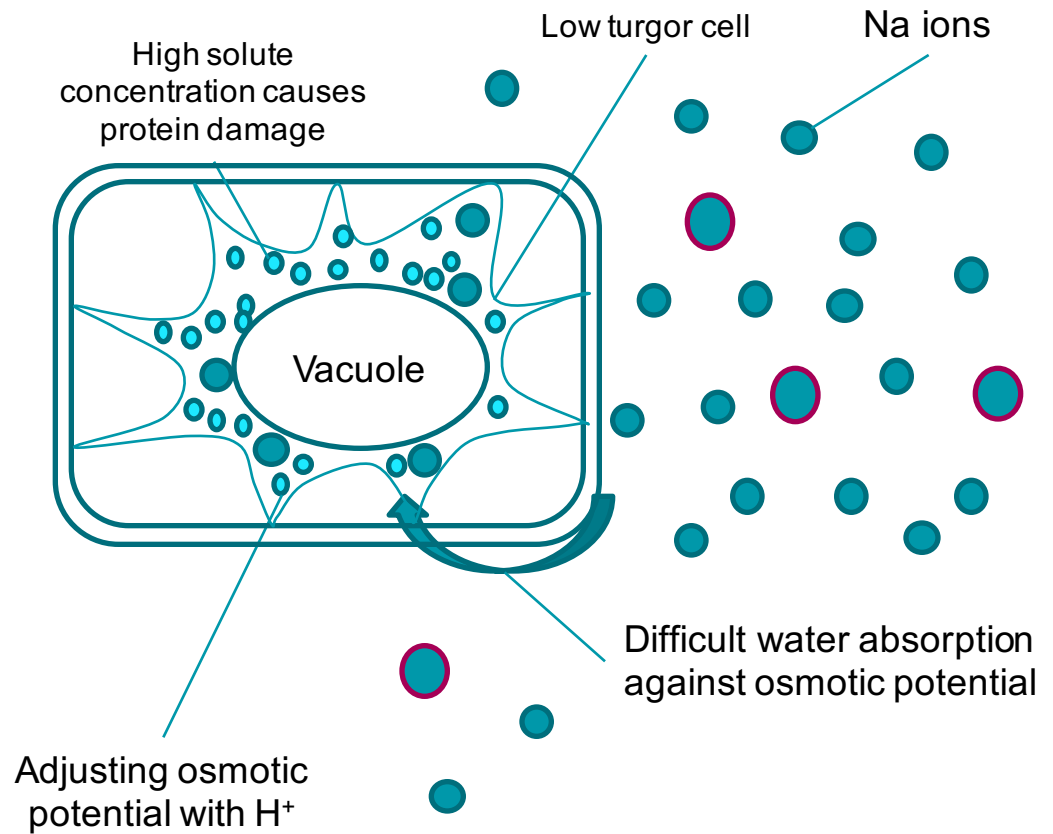
Osmotic stress explained



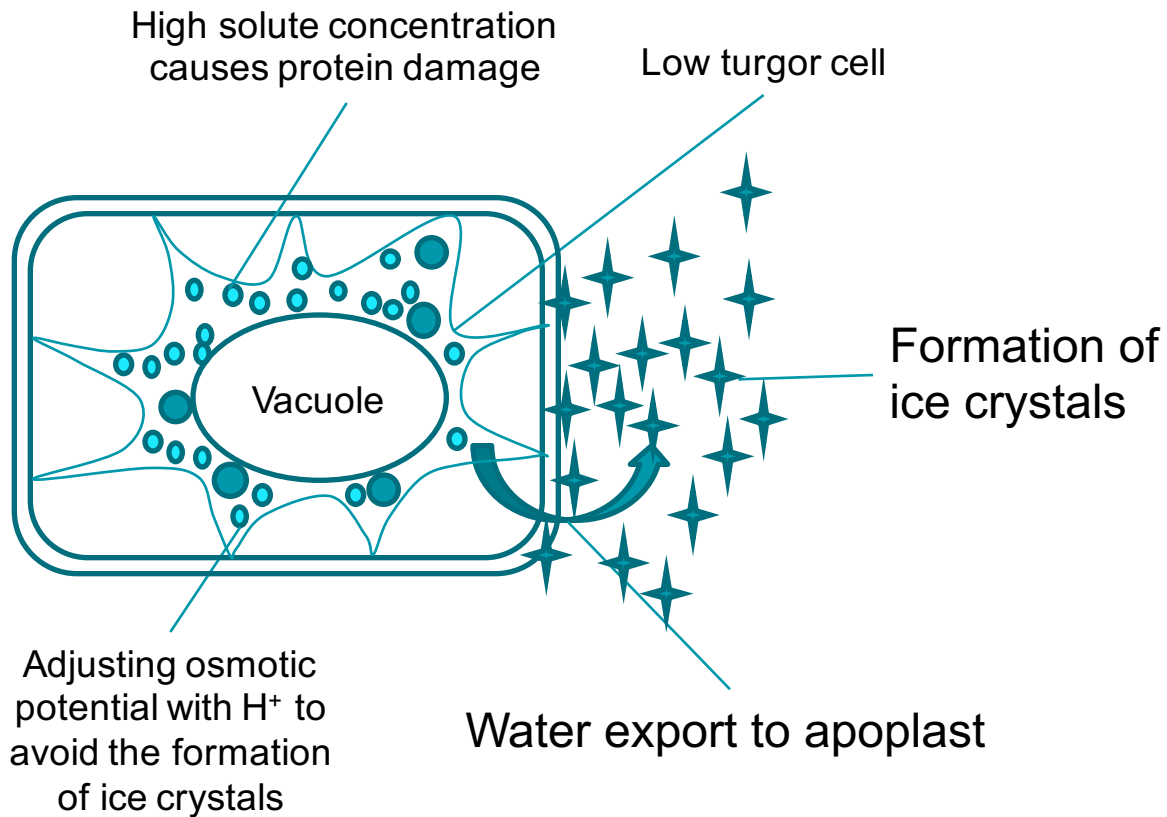
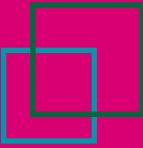
Low salt content



High salt content



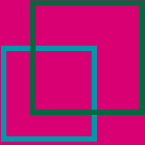
Freezing stress



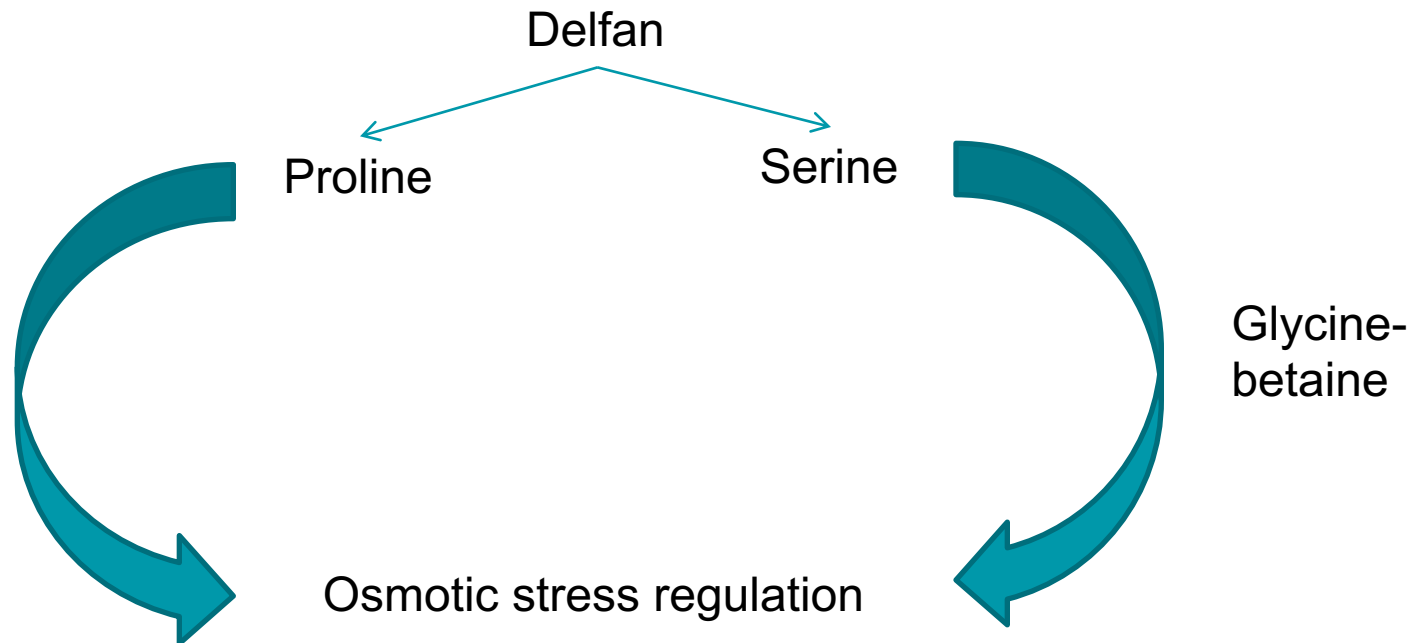
- Reduction of water potential of the cells
- Formation of crystals only in apoplast – less damage
- Osmotic stress inside cells



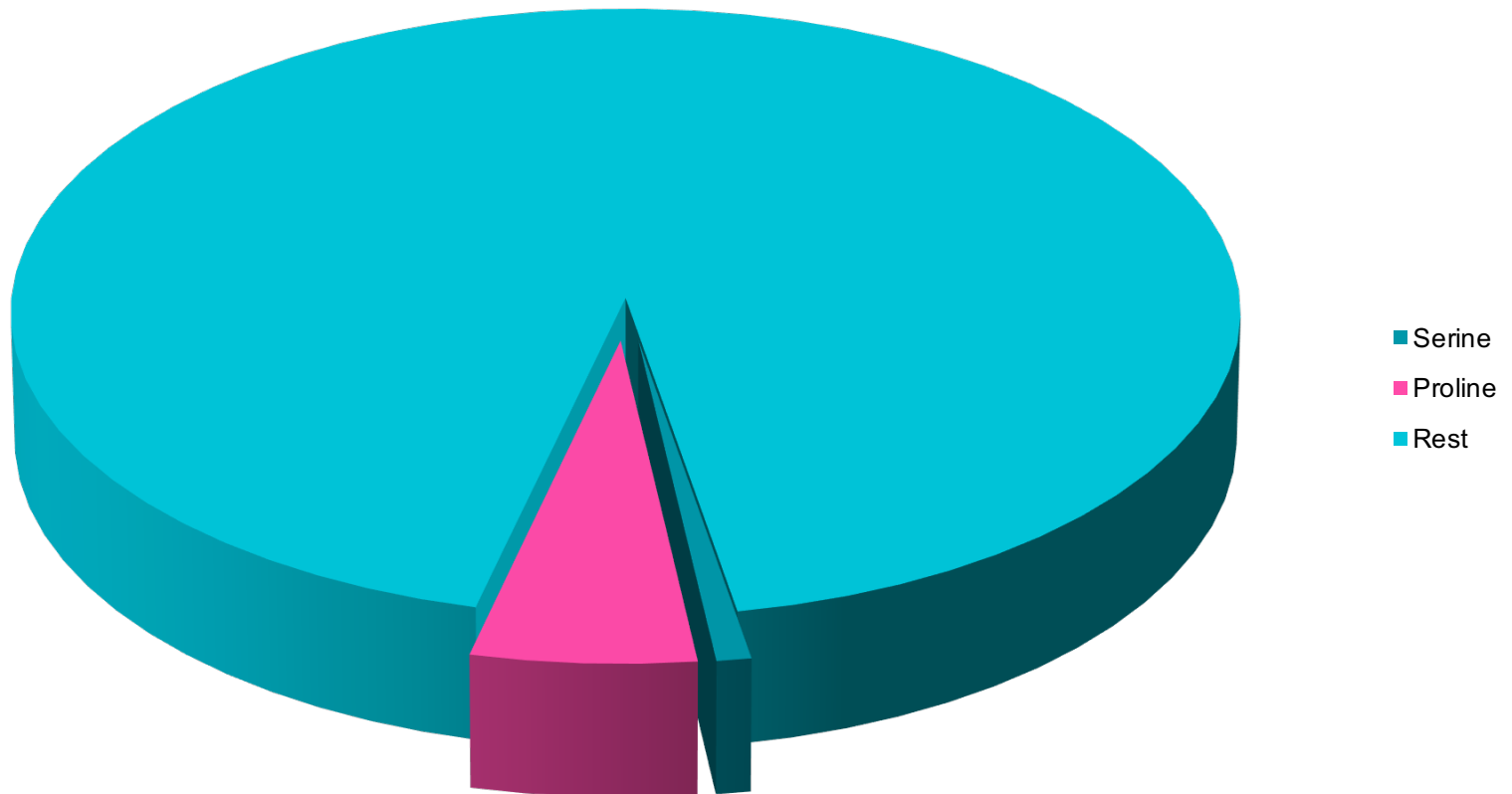
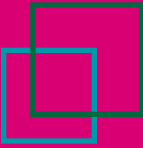
Osmolytes or compatible solutes



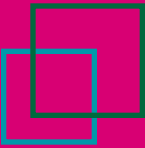
Osmolytes are non toxic substances that the plant produces to regulate the osmotic potential and detoxify the cell under stress conditions



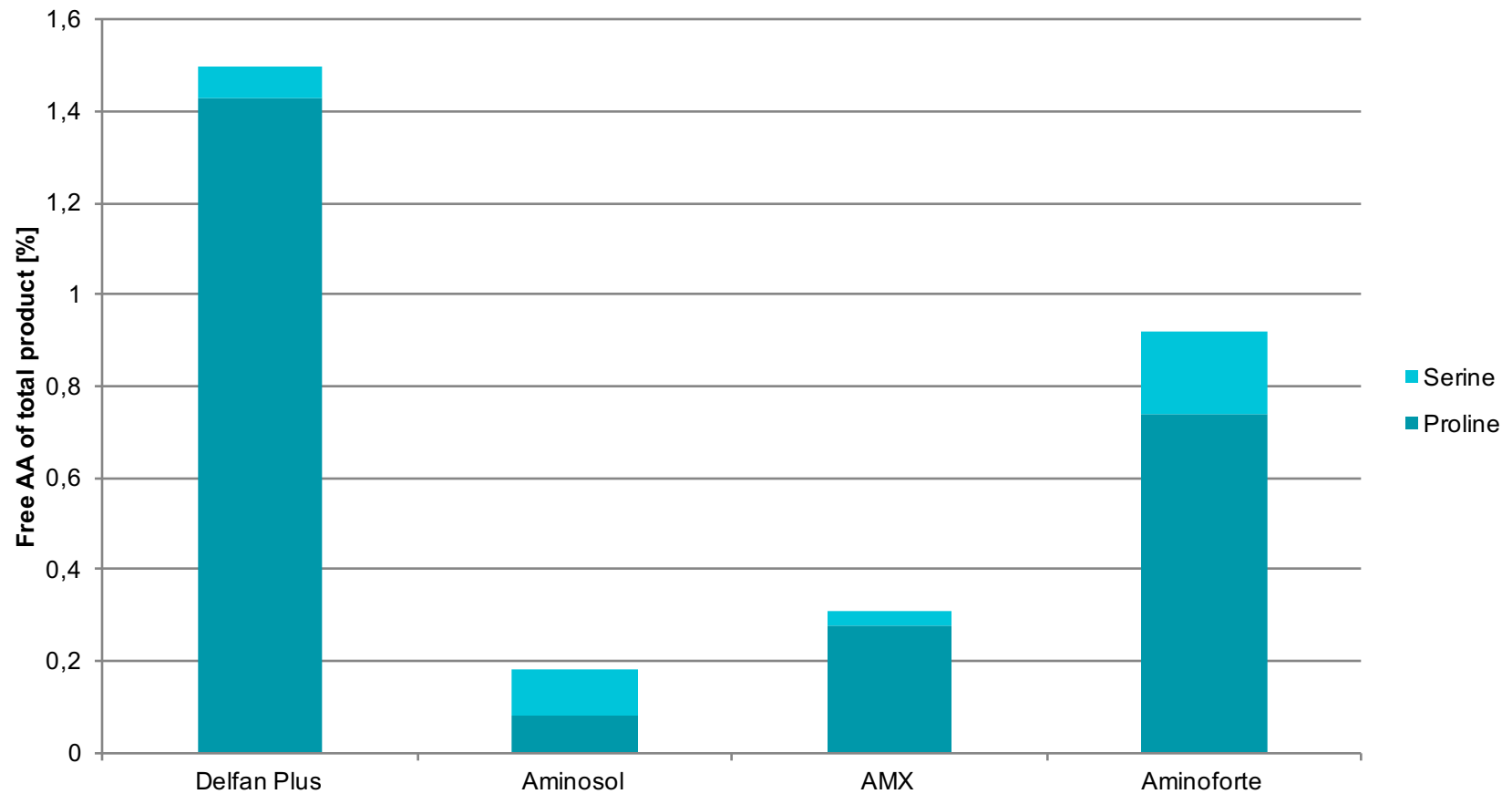
Osmolyte content of Delfan Plus



Proline and Serine content



Proline and Serine content of Delfan Plus and competitors



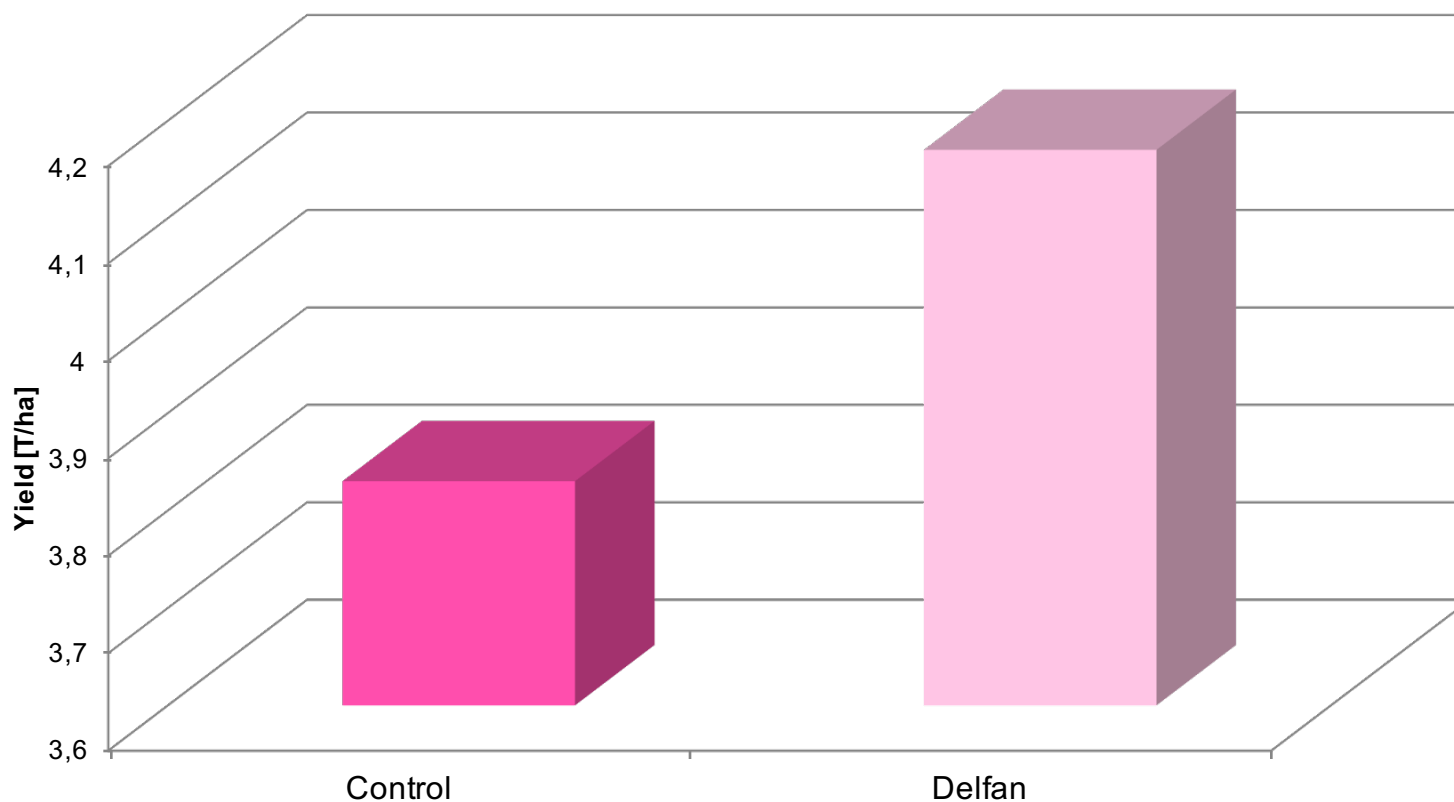
-



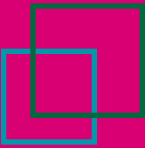
Efficiency of Delfan on Barley



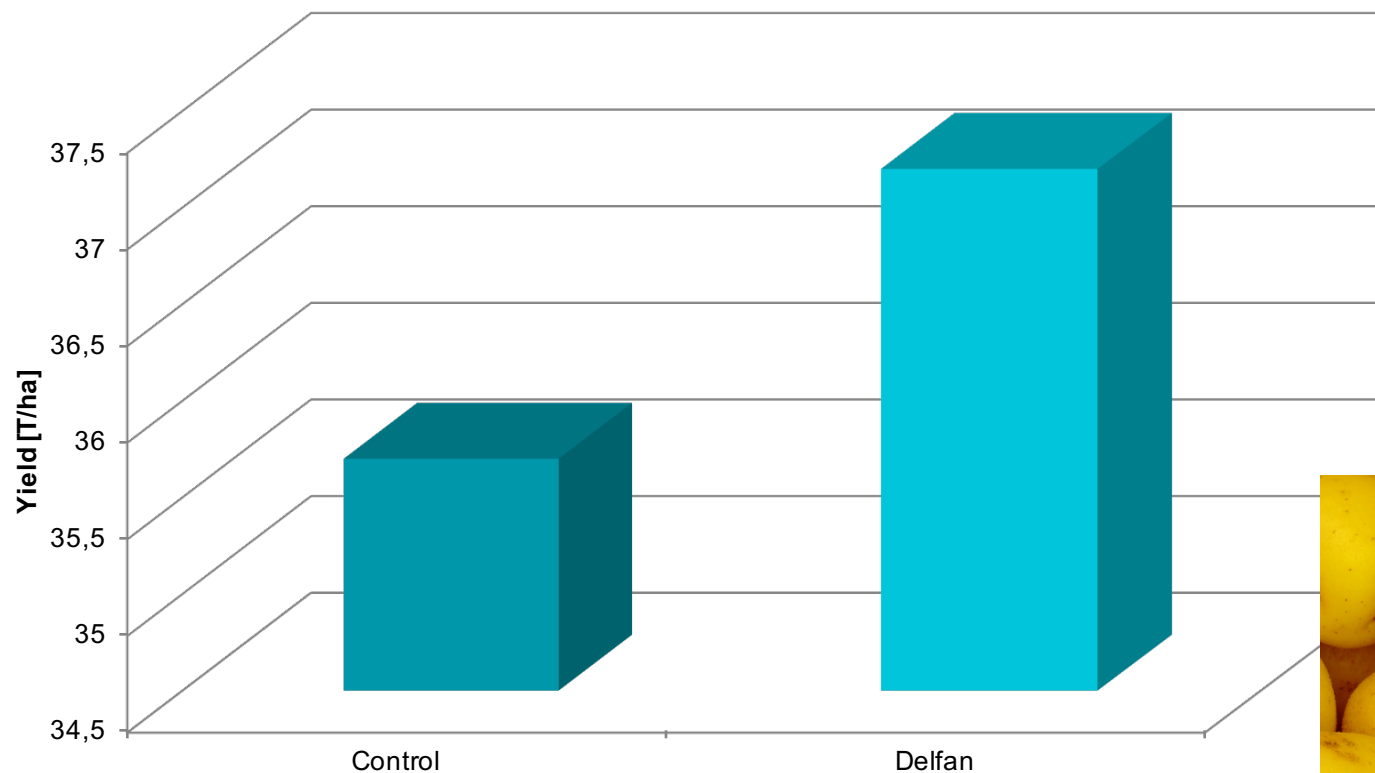
Malt Barley yield after application of Delfan at 1L/ha during stem elongation in a dry year



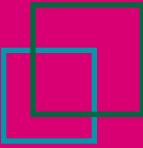
Delfan effect on potatoes during dry conditions



Yield of potatoes after Delfan applications of 1.5L/ha compared to standard in a dry year



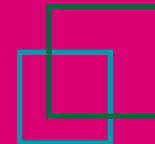
Delfan and stress prevention



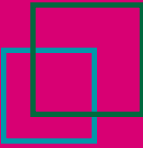
- Delfan contains osmoprotectants proline, hydroxiproline and serine
- Better tolerance to saline conditions
- Protection against dry spells
- Enhanced cold hardyness
- Enhanced yield



Delfan Plus and Ruter AA as Surfactants



Foliar uptake of Delfan



Product related factors that influence foliar **uptake**:

- Molecule size
- Hygroscopicity or point of deliquency



- Delfan has smallest possible size
- Uptake easy due to high higroscopicity

Factors that influence in plant **transport**:

- Necessity of complexation
- Amount and specialization of transporters



- Specialized tranporters available
- AA transport extremely important for plants
- Transport in Xylem and Ploem

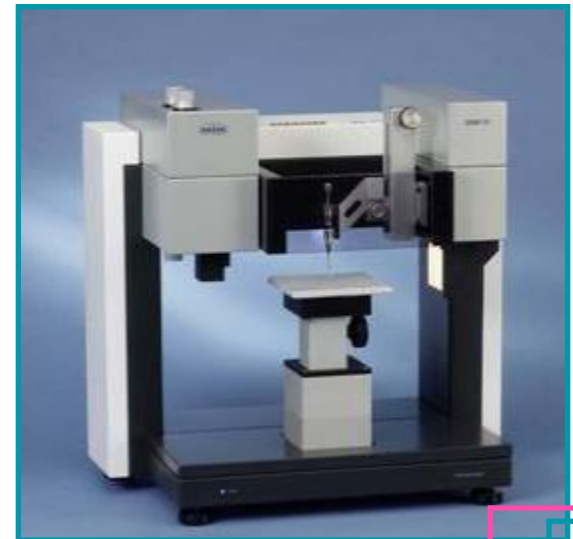
AA are a natural compound produced by plants



Measuring the surface tension

- Surfactant activity measured by: Drop Shape Analysis System DSA100B
- Measurement of contact angle and calculation of surface tension
- Products & dose rate:

Product	Dose rate
Control water	pure
Delfan® Plus	1L/100L
Ruter AA®	2L/150L



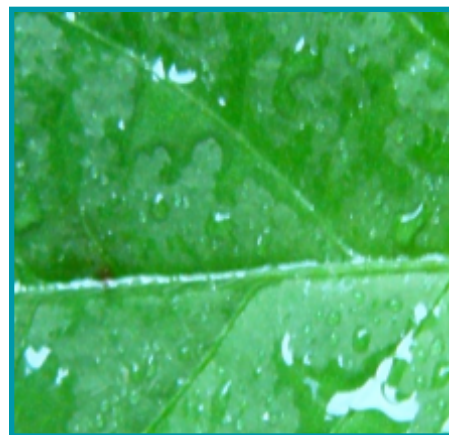
Surface tension and product efficiency



Low surface tension leads to better wetting of the leaf and higher efficiency of the application



High surface tension of water on leaf



Low surface tension – more wetting

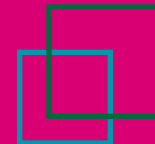
Low efficiency



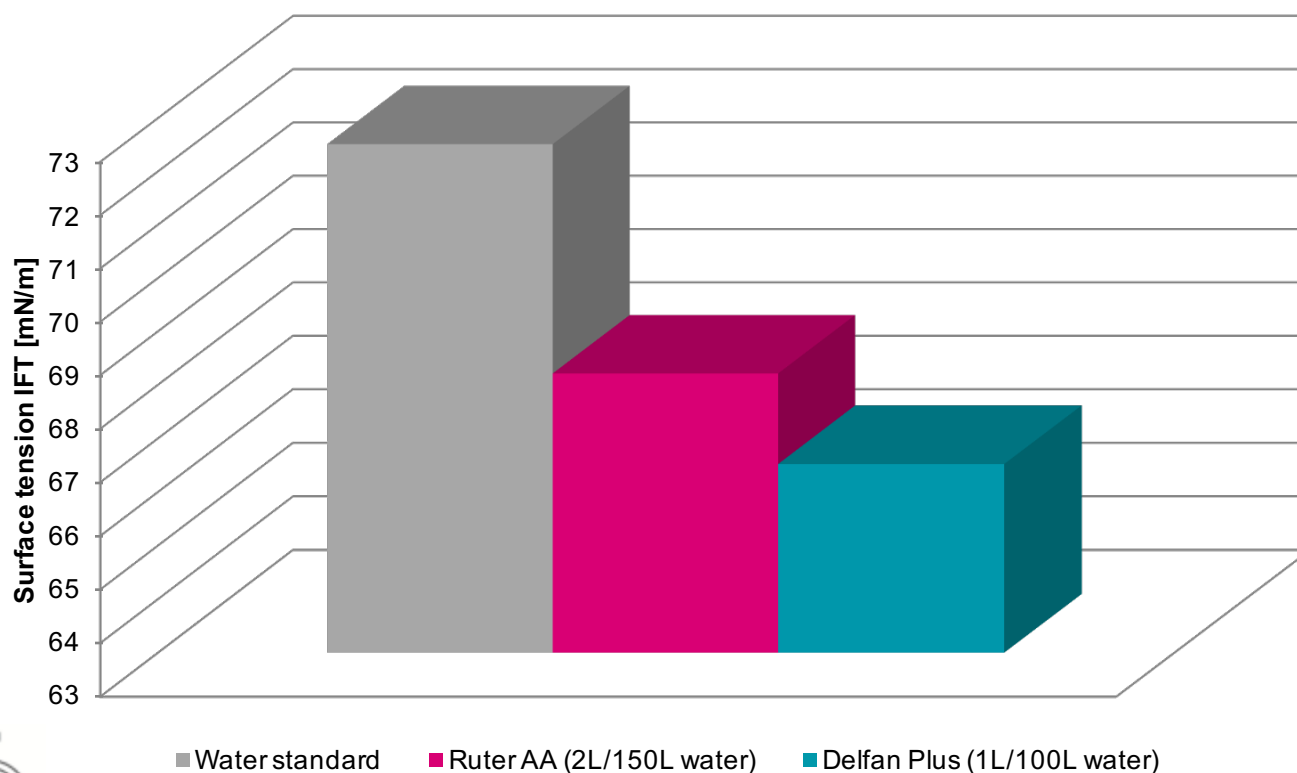
High efficiency



Surface tension of Ruter AA[®] and Delfan[®] Plus



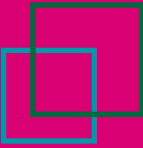
Reducing the surface tension of the spray volume with Ruter AA[®] or Delfan[®] Plus



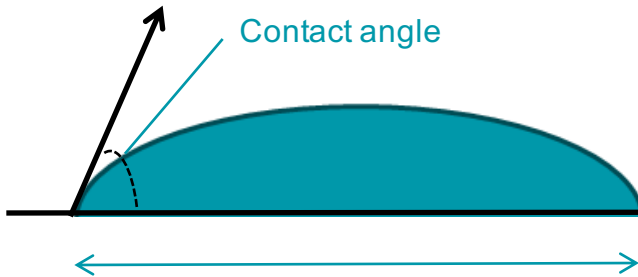
Delfan Plus and Ruter AA showed significant lower surface tension compared to the standard



Contact angle and product efficiency

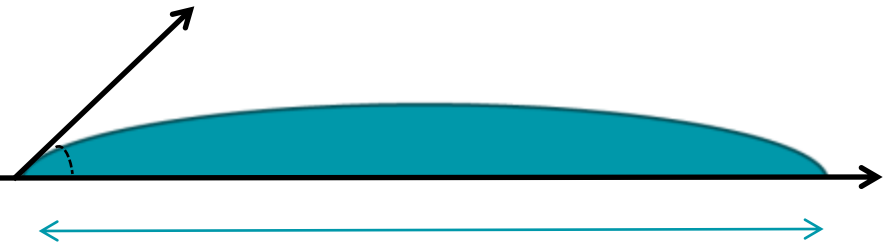


Normal water droplet



A big contact angle reduces the efficiency of the product

Water droplet with Surfactant



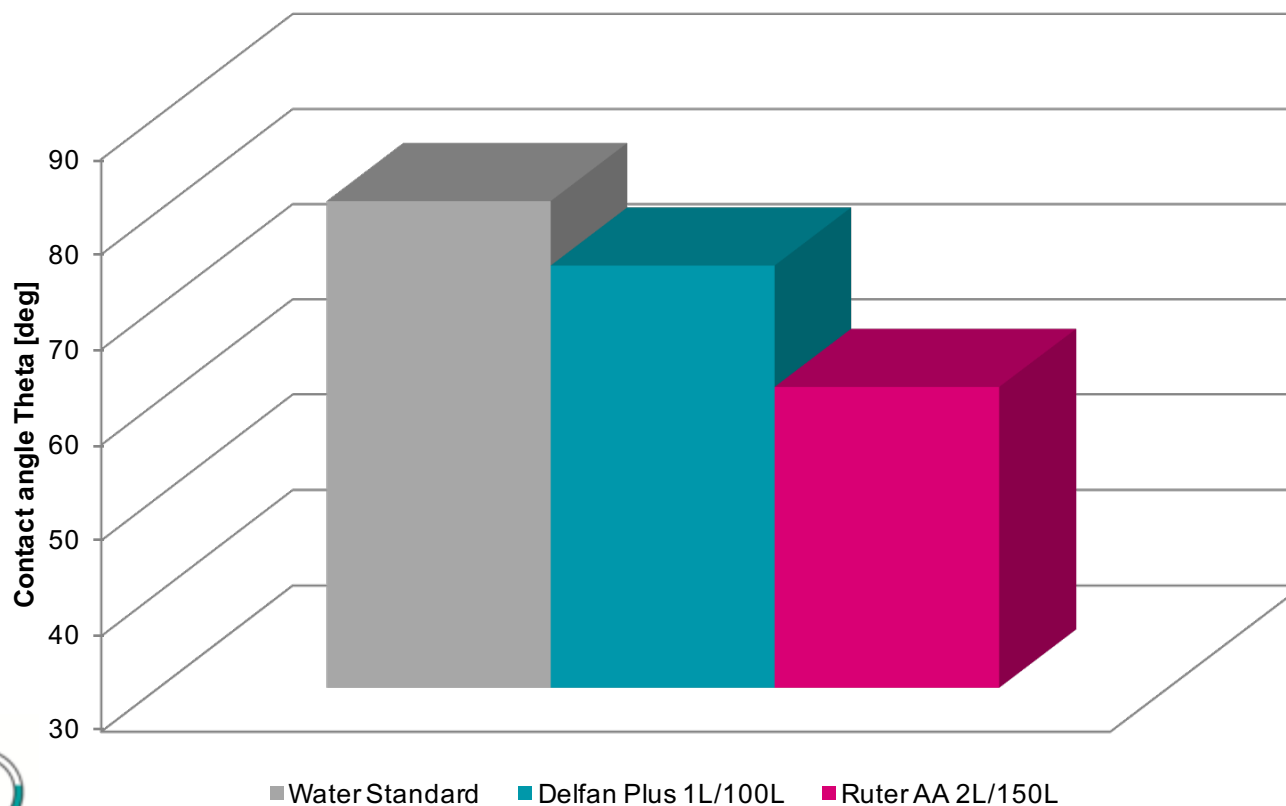
Small contact angle means

- More surface covered
- Better wetting
- Better nutrient uptake
- Higher efficiency
- Less run off



Contact angle of Ruter[®] AA and Delfan[®] Plus

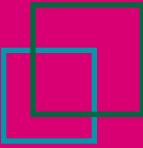
Contact angle of Delfan[®] Plus and Ruter AA[®] compared to Water



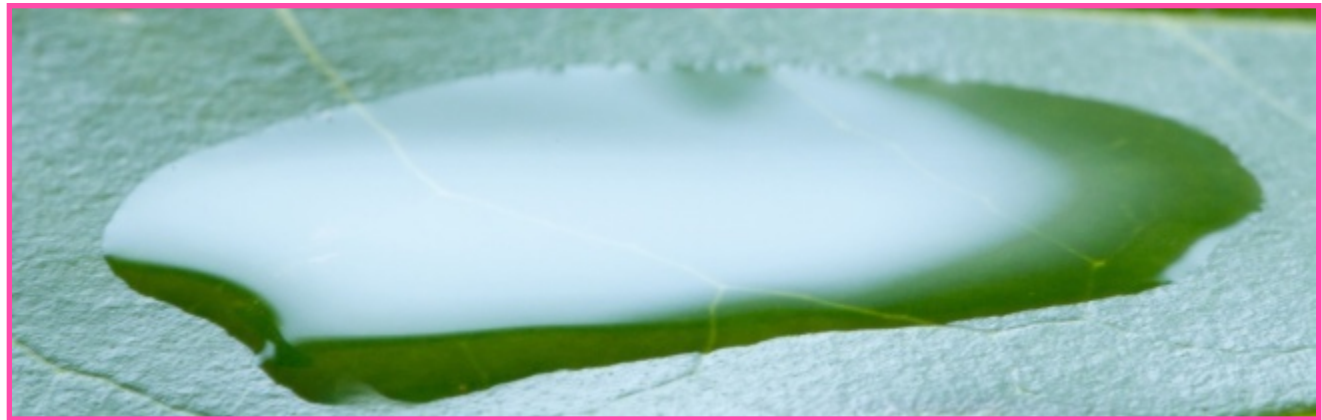
Delfan Plus and Ruter AA showed significant lower contact angles compared to the standard water



Surfactant effect



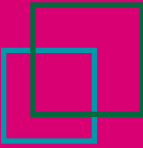
Pure water



After adding
Delfan®



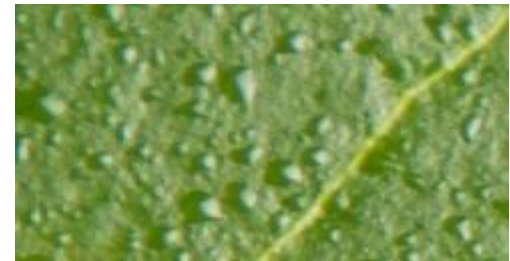
Droplet size and distribution



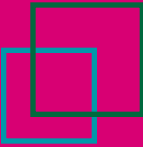
Pure water



After adding
Delfan®



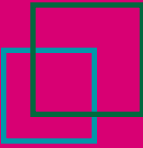
Complete leaf wetting



- Complete covering of surfaces
- Uniform wetting
- High efficiency
- Excellent uptake of active ingredients



Conclusions

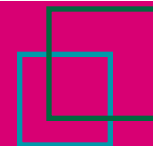


Delfan Plus and **Ruter AA**

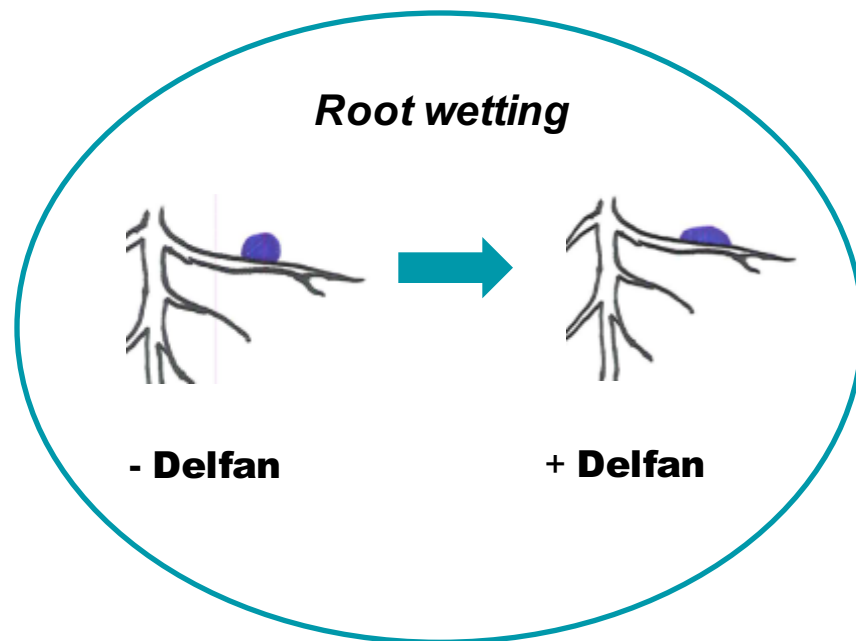
- Reduce the surface tension of spray volumes
- Reduce the contact angle of spray solutions
- Optimize the efficiency of the spray application



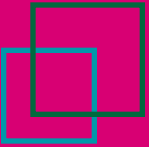
The surfactant effect in soil applications



- Enhanced root wetting
- Enhanced nutrient uptake
- Excellent biostimulating action
- Stimulation of soil bacteria



Trial on lemon trees – Soil application



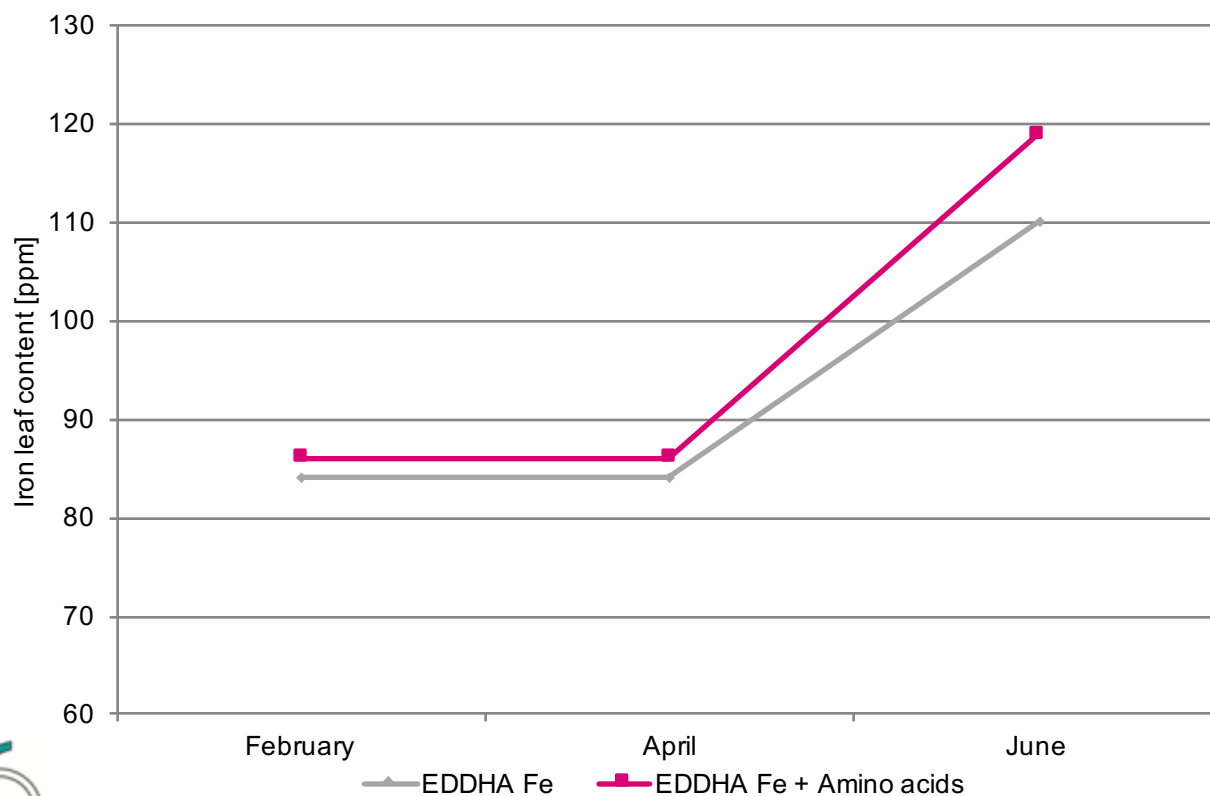
Research center:	University of Alicante
Location:	Alicante, Spain
Crop:	Lemon variety 'Fino'
Way of application:	Application with nutrient solution
Evaluations:	Iron leaf content Yield and quality parameters
Soil type:	Calcareous arid soil, pH 8.5
Dose rates:	30gr. Fe EDDHA per tree Ratio Chelate : Aminoacids 50:50
Applications:	2 applications; in February and July



Field trial on lemon trees – Iron uptake



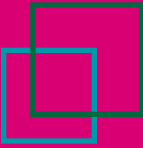
Leaf iron content of lemon trees after application of EDDHA-Fe combined with Aminoacids compared to EDDHA-Fe alone



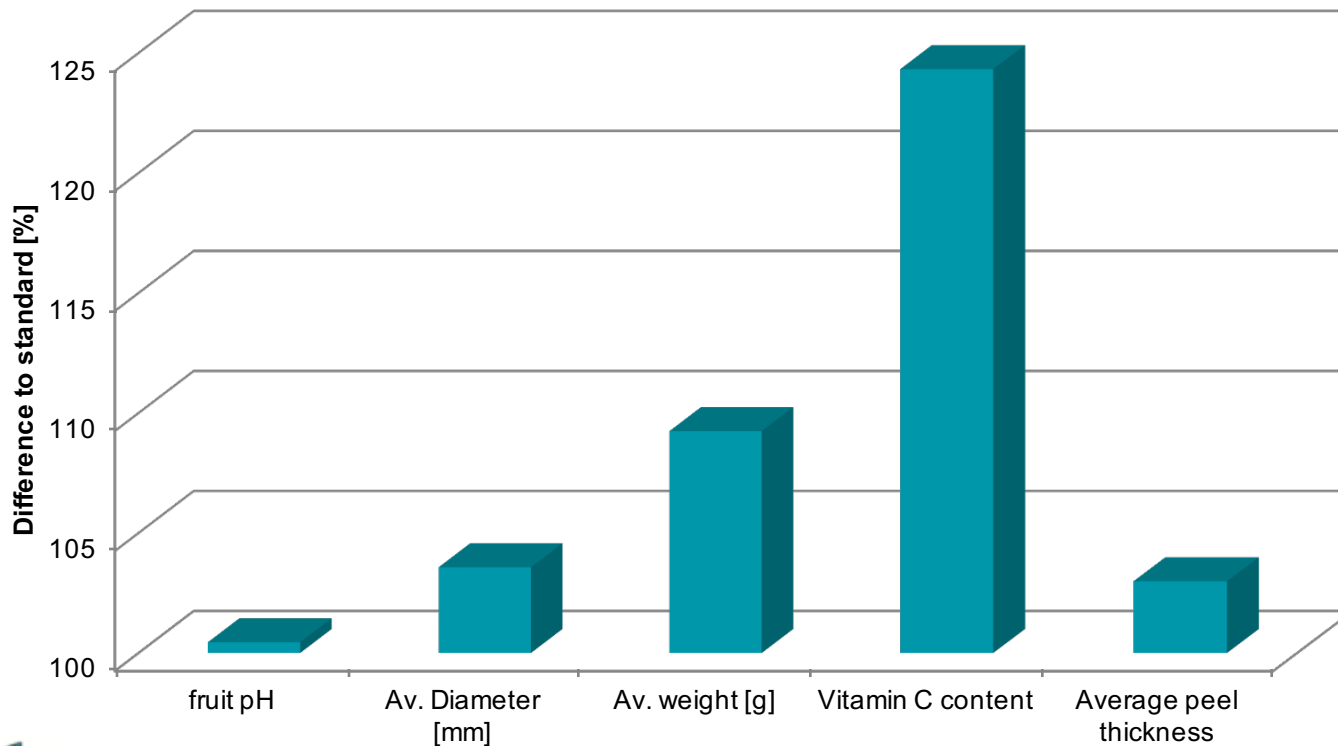
- Better efficiency
- Higher iron absorption



Trial on lemon trees – Fruit quality



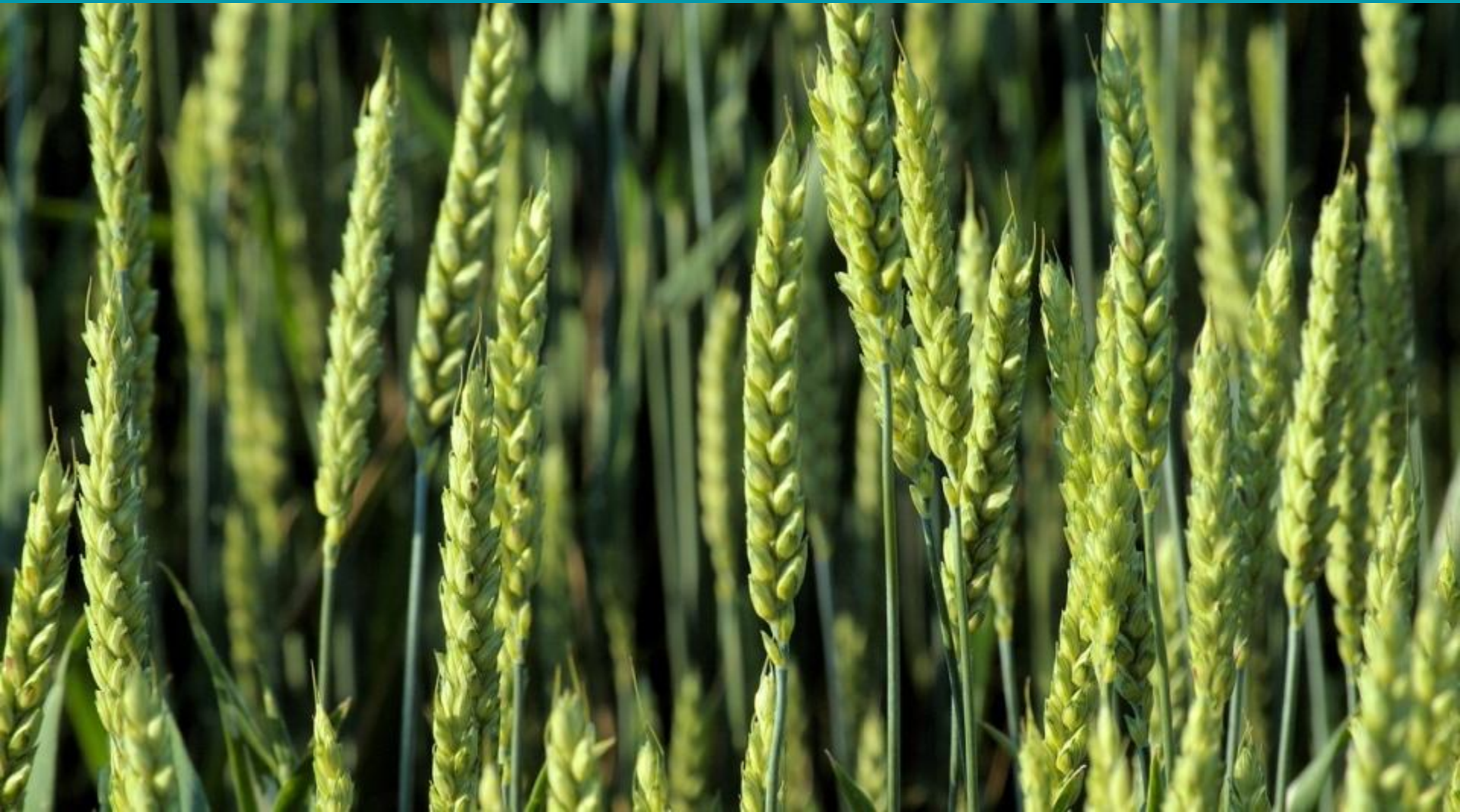
Influence of amino acid application together with EDDHA Fe compared to EDDHA Fe alone on lemon fruit



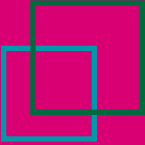
- Higher yield
- Bigger fruit diameter
- Better yield



Delfan® Plus and Ruter AA® effect on Herbicide efficiency on Wheat



Trial Description



Research centre: Hogeschool Gent
Location: Belgium
Crop: Wheat
Way of application: Application together with herbicides
Evaluations: Damage on weed and wheat

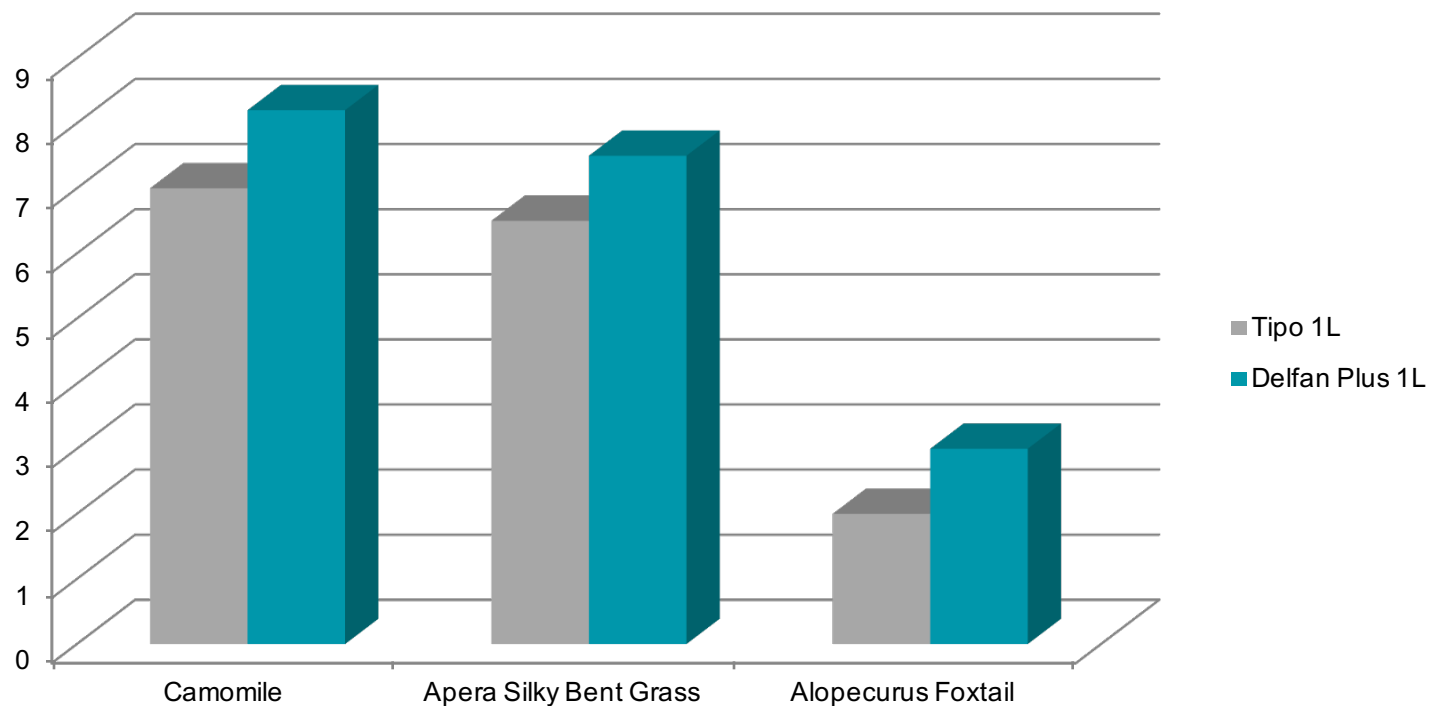
Time of application		Herbicide combination	Surfactant	Dosage
T1	9 th of October	Kapri twin 200g + Lexus Milenium 70g	Tipo	1L
T2			Delfan Plus	1L
T3			Ruter AA	1L
T4	23 rd of October	Kapri Twin 200 g + Alister 0,6 L	Tipo	0,5L
T5			Delfan Plus	0,5L
T6			Ruter AA	0,5L

- Kapri Twin, Herbicide for winter cereals, Dow Agro science, (Pyroxulam 6.8%, Florasulam 2.3%, Clorquinotect-Mexyl 6.8%)
- Lexus Millenium, Herbicide for winter cereals, DuPont, (Flupyrsulfuron methyl and Thifensulfuron methyl)
- Alister, Bayer, Post crop emergende herbicide for winter wheat, (Diflufenican, mesosulfuron-methyl, iodosulfuron-methyl-sodium)
- Tipo, Sterified rapeseed oil

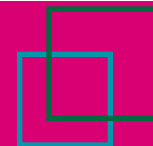


Effect of **Delfan® Plus** combined with herbicides on weed

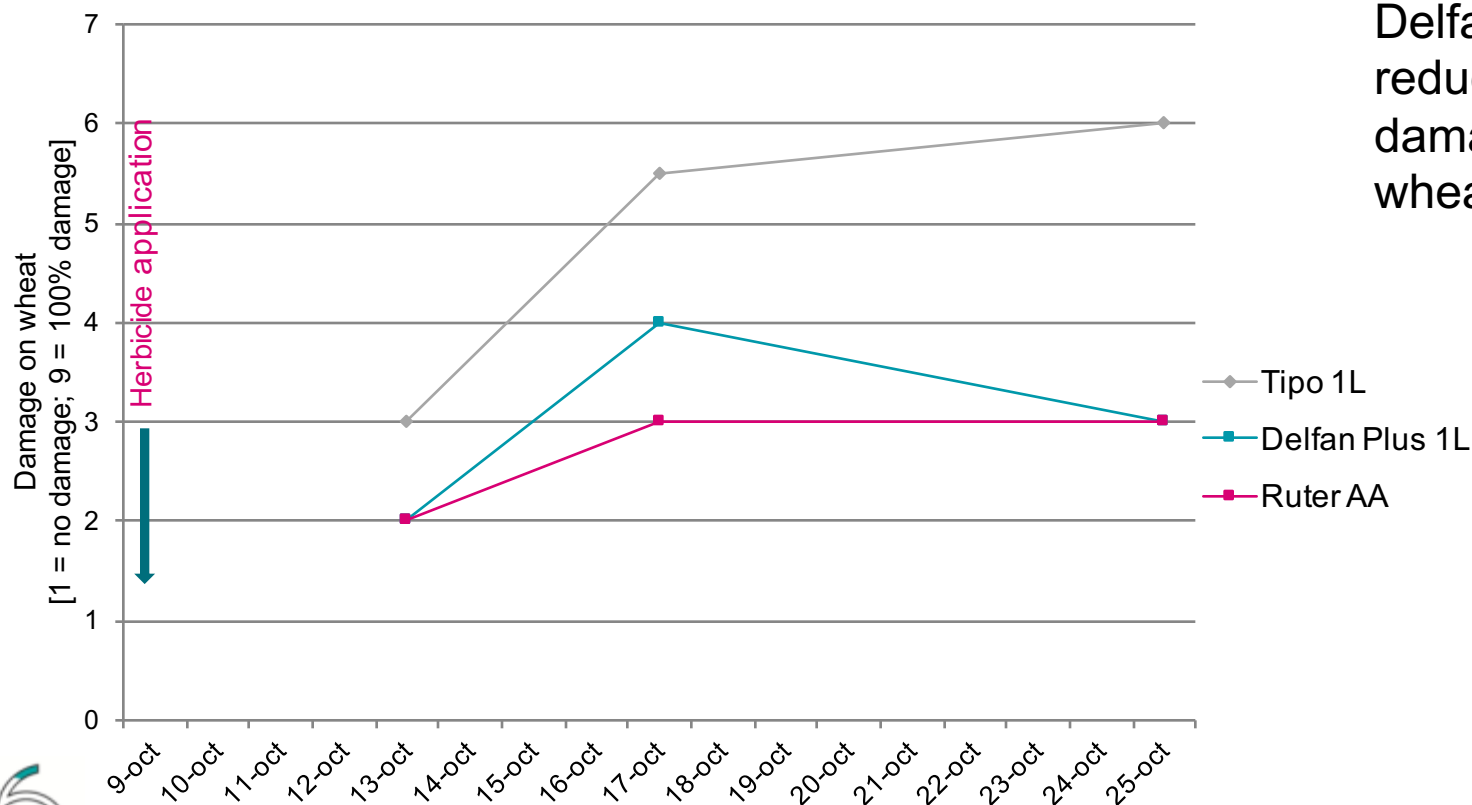
Damage of Capri Twin and Lexus combined with **Delfan® Plus** on weeds



Damage Evaluation of the treatments on wheat

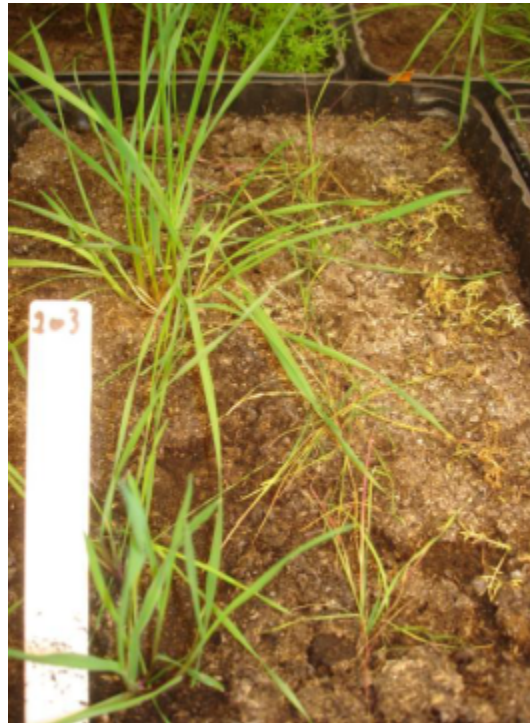
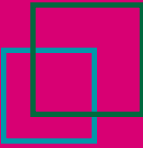


Damage of herbicide Lexus Millenium combined with Delfan® Plus, Ruter AA® or Tipo in the growth of wheat



Delfan Plus reduced the damage on wheat by **22%**



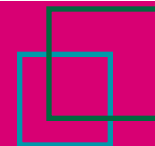


Delfan® Plus

- Enhances the efficiency of herbicides
- Reduces crop stress
- Enhances crop recovery



Phytotoxicity of herbicides on soy beans

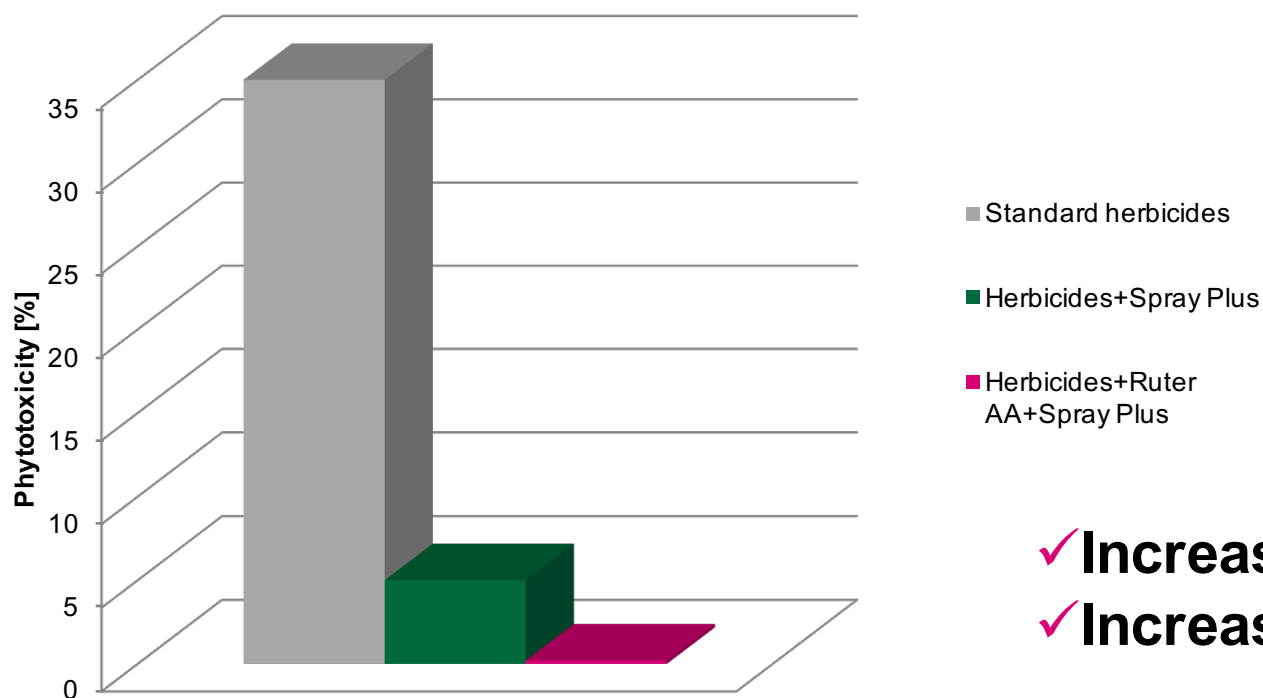


Crop:	Soybean
Product:	Spray Plus [®] and Ruter AA [®]
Application:	Post emergence
Dosage:	2 l/ha Ruter AA [®] + 30 ml/hl Spray Plus [®] + post-emergence herbicides
Contractor:	private trial (Italy)
Parameters assessed:	weed control (%) and phytotoxicity



Phytotoxicity of herbicides on soy beans

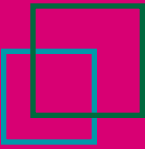
Phytotoxicity of herbicide combinations with Spray Plus and
Spray Plus® with **Ruter AA®** compared to the standard



- ✓ Increased efficiency
- ✓ Increased selectivity

The control of *Abutilon theophrasti*, the most damaging weed species, improved by 10%.





Thank you for your attention

Delfan[®] Plus

