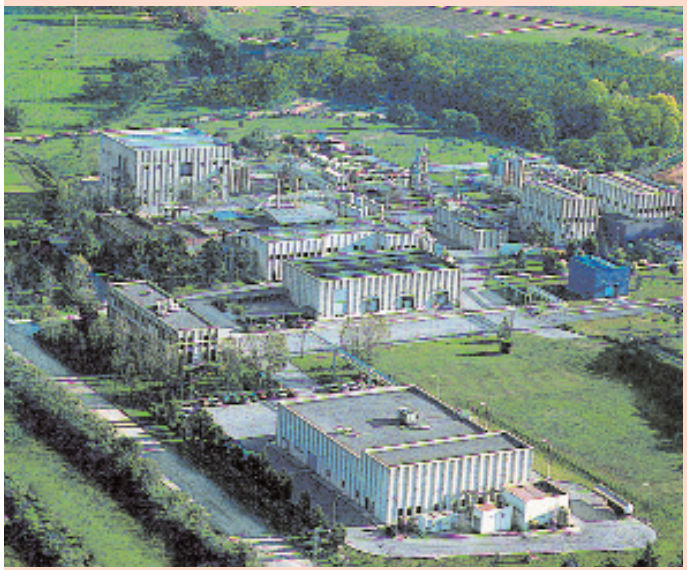
AminoQuelant®-K

Potassium and Amino Acids

Fast uptake Potassium

BIOIBERICA
PLANT PHYSIOLOGY

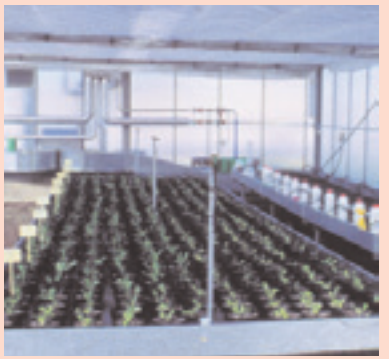
Technical Dossier



In recognition of this constant commitment to innovation and improvement, ***BIOIBERICA*** *has been granted ISO 9001 for Quality Management as well as ISO 14001 certification for its successful policy of respect for the environment.* ***BIOIBERICA*** *is the first company in the Spanish chemical - pharmaceutical sector to obtain this accreditation.*

cGMP

BIOIBERICA : Research for progress.



Since 1975, year of its foundation, ***BIOIBERICA*** *has consolidated its high technological level in all areas of performance: raw materials and preparations for the pharmaceutical, cosmetic, animal nutrition, veterinary and AGRICULTURAL industry.*

In the Agricultural field, ***BIOIBERICA*** *has been manufacturing and marketing its own products on the home and international market place since 1986, exporting to more than 40 countries.*

The proven quality and efficacy of the products in the ***Terra-Sorb***® *and* ***AminoQuelant***® *range as well as the in-house technology for obtaining active Amino Acids (L-α- Amino Acids) using an exclusive Enzymatic Hydrolysis process, has enabled* ***BIOIBERICA*** *to consolidate itself in the field of plant nourishment as leader and specialist in Amino Acids.*

BIOIBERICA *has an important industrial complex with a floor space of 100,000 m² located in the Can Puigvert Industrial Estate, Palafolls, Barcelona, as well as production facilities in Toledo (Spain), Nebraska (USA) and Linyi (China). These facilities are fully equipped with the most advanced techniques for extraction, purification, freeze-drying, micronization, ultrafiltration and atomisation.*

The R&D Department and its skilled staff of Chemists, Biochemists, Pharmacists, Doctors, Biologists, Veterinarians and Agronomists, works on the development and preparation of new processes and substances in close collaboration with various Universities and international and national Scientific Institutions.

AminoQuelant®-K

Fast uptake Potassium

AminoQuelant-K is a liquid formula based on **Potassium combined with Enzymatically Hydrolysed L-α-Amino Acids** specially developed by ***BIOIBERICA*** for use as a nutritional supplement and biostimulant for all types of crops through foliar spraying or fertirrigation.

The presence of Enzymatically Hydrolysed L-α-Amino Acids and low molecular weight peptides potentiates the absorption and translocation of Potassium to all parts of the plant.

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What is AminoQuelant-K?

AminoQuelant-K is a liquid **Potassium** formula combining **Enzymatically Hydrolysed Free L-α-Amino Acids** developed by ***BIOIBERICA*** as a nutritional supplement and biostimulant to increase the yield of crops and improve the quality of fruit and vegetables.

Composition:

Potassium (K_2O)	**45 %** (w/v)	**30 %** (w/w)
Enzymatically Hydrolysed Free L-α-Amino Acids	**7.5 %** (w/v)	**5 %** (w/w)
Total Nitrogen (N)		**1 %** (w/w)
Organic Nitrogen		**1 %** (w/w)
α-amine Nitrogen		**0.8 %** (w/w)

Characteristics:

- Fast uptake.
- High tolerance by crops even at high doses.
- No environmental impact:
  - Totally biodegradable.
  - Absence of any heavy metals.
  - Free of microbial contamination.
- Chlorine-free.

- The **synergy** between **Potassium** and **Enzymatically Hydrolysed Free L-α-Amino Acids** improves the absorption, translocation and activity of Potassium within the plant.
- It is specially indicated to improve fruit quality: sugar content, colour, flavour, ripeness, hardiness, preservation, etc.
- It is also recommended **in cases of stress** where the plant may have difficulties with Potassium absorption (cold, heat, salinity and drought) and to potentiate the natural defences of the plant against plagues and attacks by micro-organisms.
- The product can be applied either **by foliar or radicular route**. By foliar route, AminoQuelant-K is almost totally **absorbed in less than 6 hours**. However, by radicular route it has a longer lasting effect.

What are the advantages of AminoQuelant-K?

Fast uptake Potassium.

- Potassium is the quality element. It is the main mineral component in vegetables and it is involved in practically all metabolic processes.
- The Potassium needs of any plant are extremely high, specially during fruit development and ripening phases.
- The Potassium provided by AminoQuelant-K is quickly absorbed due to the action of the L-α-Amino Acids and transported to consumption points much more effectively than other Potassium solutions.

It provides the plant with Enzymatically Hydrolysed L-α-Amino Acids.

- The L-α-Amino Acids in AminoQuelant-K as well as in the Terra-Sorb range of products are the basic constituents of vegetable life (they are the base for proteins).
- The Enzymatic Hydrolysis process developed by ***BIOIBERICA*** provides a complete mixture of all proteic L-α-Amino Acids, the only biologically active Amino Acids, so that the plant can incorporate them directly into its metabolic processes.
- Amino Acids increase the permeability of cell membranes and bond to ions forming complexes, favouring the absorption and transportation of the nutrient.

AminoQuelant-K bases its efficacy on the natural synergy between Potassium and L-α-Amino Acids

- Potassium and L-α-Amino Acids are involved in osmoregulation, stomatal opening and closing, and also foster photosynthesis.
- Potassium and L-α-Amino Acids participate directly in improving the resistance and recovery of plants in stress situations.
- The Potassium acts as an enzyme activator and regulates the synthesis of proteins, substances formed by chains of L-α-Amino Acids.
- Potassium and L-α-Amino Acids are directly implicated in the processes related to ripening, increasing fruit quality.

D-α-Amino Acid

Has the NH_2 group on the right of the asymmetrical carbon atom.

L-α-Amino Acid

Has the NH_2 group on the left of the asymmetrical carbon atom.

The only one that is biologically active.

Figure 1. Chemical structure of D and L-α-Amino Acids.

Symptoms of Potassium deficiency:

- Chlorosis and subsequent necrosis of the tips and edges of the leaves. Sometimes the edges tend to curl.
- Initial clhorosis appearence in old leaves.
- With extreme deficiency, plant growth is reduced with the corresponding loss of turgidity and general withering of the plant.
- Fruits do not develop correctly, presenting problems in colour, ripeness, texture as well as low sugar content and acidity.

Potassium needs are specially high during the stages of fruit development, growth and ripening.

How does AminoQuelant-K work?

AminoQuelant-K provides fast uptake Potassium to correct Potassium deficiency and to increase the quality of the crop.

A lack of Potassium during fertilisation has a negative effect on productivity and fruit quality, even though no obvious signs or symptoms of this deficiency are observed.

Effects of the application of AminoQuelant-K.

Culture	Effects
Lettuce, spinach, celery	Greater growth and colour of the leaves; more resistance to fungi attack.
Cucumber, Zucchini, Pepper	Increase in the size and homogeneity of the fruit; earlier ripening and reduced malformation.
Tomato	Homogeneous ripening, uniform colour brought about by the potentiation of pigment synthesis. Improved ripening in winter, when less light is available.
Flowers	Increased, earlier, more even flowering. Improved colouring in flowers. Greater turgidity of leaves.
Fruit-bearing crops	Less chlorosis and necrosis in old leaves. Earlier ripening, even better colouring. More evenly sized.
Citric fruits	Less chlorosis and necrosis in old leaves. Earlier ripening and better colouring, with more even fruit sizes. Greater resistance and recovery from exposure to low temperatures.
Olive trees	Earlier, more even ripening. Increase in the specific weight of the fruit. Improved resistance and recovery in the event of cold, drought and/or attack by micro-organisms.
Tropical fruits	Improves fruit formation. Favours ripening. Corrects chlorosis in old leaves.
Grapevines -Trellised	Improved budding. Better development and colouring of the fruit. Reduction of attacks by micro-organisms, specially fungi. Favours a higher alcohol content in the must.
Potato	Prevents malformation of the tubers. Improved quality of the tuber, less oxidation once cut because of an increased supply of antioxidant substances.

Effects of the application of AminoQuelant-K. Increased absorption and transportation of Potassium.

Why does AminoQuelant-K promote greater absorption and transportation of Potassium?

- The fast Potassium uptake rate after AminoQuelant-K application is due to the effect of its combination with L-α-Amino Acids.
- Most of this Potassium is transported through the plant by means of Potassium channels found in cell membranes. Transportation can be, depending on the circumstances, passive (by simple diffusion) or active (with consumption of energy).
- Active transport of Potassium takes place through Potassium pumps that increase absorption, specially under conditions of an unfavourable osmotic gradient.
- These channels, or pores, are made up of membrane proteins that change their structure from open to closed as a result of the sequence of Amino Acids that combine with the channel. Depending on this structure of the channel, the absorption and transport of Potassium can be increased by up to 10,000 times. (Figure 2)
- The application of L-α-Amino Acids encourages the open structure of these channels and therefore the greater absorption and transport of Potassium.

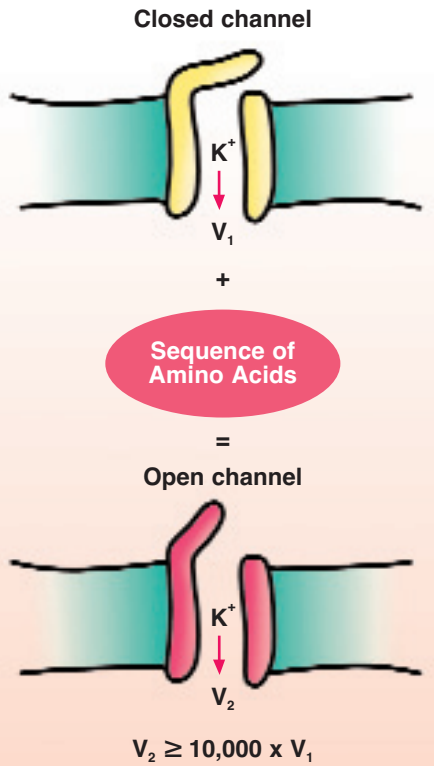


Figure 2. Variation of the Potassium transport rate (V_1 and V_2) through a membrane channel. The bonding of L-α-Amino Acids to the channel leads them to adopt the open configuration.

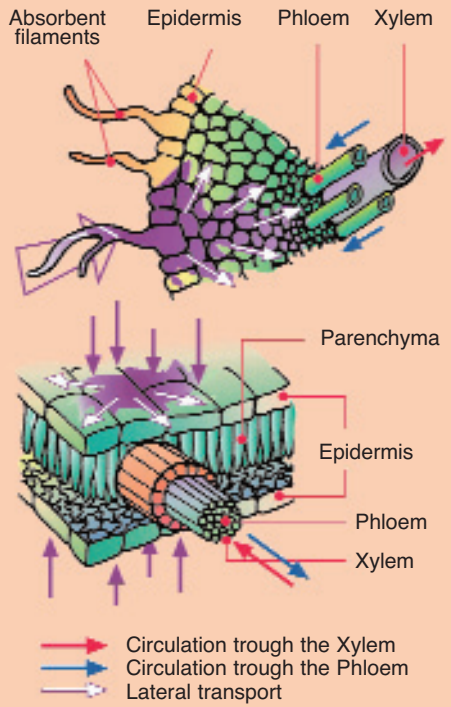


Figure 3. Absortion and translocation of Potassium in the root and leaf.

Stress hinders absorption and transport of Potassium in the plant, specially in situations of low temperatures or in the presence of ions that compete with Potassium (as in the case of unbalanced fertilisers and saline soils or water).

Movement of Potassium in the plant. The effect of Amino Acids.

The mechanisms for the absorption and translocation of Potassium within the plant were unknown until quite recently; over the last few years important discoveries have been made about the process this element uses to move inside plants.

Potassium in the soil: availability for the plant.

- Only a small part of the Potassium in the soil (less than 5 %) is available for plants; and this is the part that is found in the soil solution and the clayish - humic complex (interchangeable Potassium). Furthermore, it must also be found near the roots and dissolved in water so that the plant can absorb it.

Root Absorption.

- Potassium mainly enters the root through the cells of the epidermis with root hairs. It has been observed that the capacity of these cells to absorb Potassium is far greater than the other cells of the epidermis. This is because they have a large number of channels that are activated by Potassium pumps. Absorption is initially passive but as Potassium concentration in the rhizosphere is reduced, it becomes necessary to use Potassium pumps and this means that the open configuration of these channels is of prime importance.
- The application of L-α-Amino Acids promotes the formation of large quantities of root hairs and improves the permeability of the membranes, facilitating Potassium absorption.

Movement towards conducting vessels.

- The lateral movement of Potassium from the epidermis, through the parenchyma to the xylem, takes place passively because of the simultaneous difference of concentration gradient in intercellular spaces (apoplast route) as well as from cell to cell through cytoplasmic joints (plasmodesmata route).

Entry in the xylem.

- The secretion of Potassium into the sap is performed actively through specific channels. These channels are also composed of Amino Acids, different from those of the epidermis, which are located in the cells of the root adjacent to conducting vessels. The operation of these channels is controlled by abcisic acid, one of the main vegetable hormones of stress.

Transport by xylem and phloem.

- Potassium is a mobile element that within the plant, it is translocated through either the xylem or the phloem. Potassium is the most prevalent mineral ion in the sap and is also found in large quantities in the phloem. The most common organic compounds present in xylem vessels are Amino Acids and other organic acids. Potassium favours the transport of photosynthates (sugars) and other substances through the phloem: it contributes to creating osmotic pressure and accelerating the phloem flow rate. The ascension of the sap is favoured by this transpirational flow.

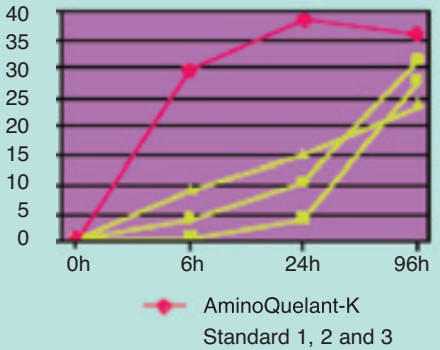
Accumulation.

- Within the plant, both Potassium as well as free L-α-Amino Acids are mainly found in the active growth organs such as buds, young leaves and the tips of the roots. This is why Potassium deficiencies generally occur in old leaves. A large amount of Potassium is also accumulated in the fruit.

Foliar absorption.

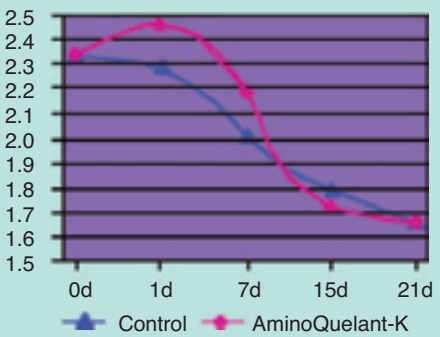
- It is also possible for Potassium to penetrate into conducting vessels through foliar applications. It has been demonstrated that the AminoQuelant-K complex greatly improves foliar absorption of Potassium by increasing the permeability of cell membranes even though it is not the usual route the plant uses to absorb this element. Transport across membranes is carried out mainly through Potassium channels in exactly the same way as in the case of radicle absorption.

% Potassium increase in leaves.
Efficacy compared to the control.



Graph 1. Increase in the Potassium content of tomato leaves (var. Durinta) in 4 treatments, one with AminoQuelant-K and the 3 others with Potassium solutions (standard 1, 2 and 3).

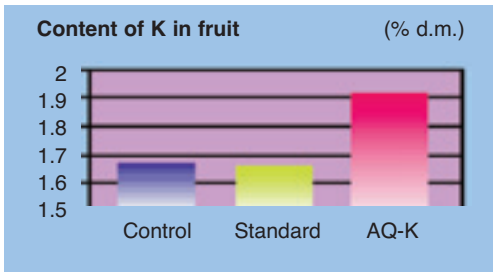
% K in leaves (% d.m.)

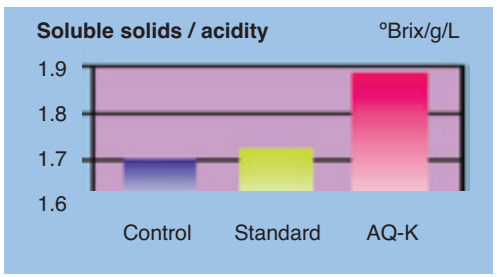


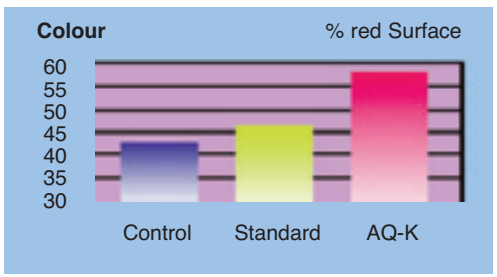
Graph 2. Potassium content in leaves without application (control) and with application of AminoQuelant-K evaluated over time. (d = days) Crop: lawn (*Agrostis stolonifera*).

Proved effects in field trials

In a trial performed by the CSIC (Consejo Superior de Iivestigaciones Científicas), in the Aula Dei experimental agricultural farm (Zaragoza, Spain) on "Suncrest" peach with application of AminoQuelant-K (AQ-K), a standard product (30% K_2O) and a control without Potassium application.







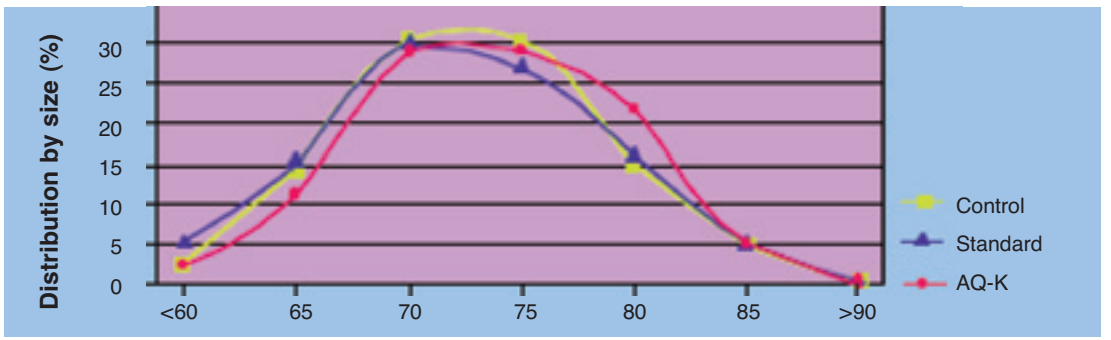
AminoQuelant-K. Effects on fruit quality.

As it has been shown before, Potassium and L-α-Amino Acids have a large capacity to transport nutrients and other assimilated substances.

On the other hand, Potassium is directly involved in the enzymatic processes related to ripening, while certain Amino Acids intervene in the organoleptic characteristics and in the formation of pigments. More specifically, glycine, alanine and proline help in the formation of tastier fruit and arginine increases the refreshing sensation. Other Amino Acids, such as phenylalanine, are indispensable for the formation of anthocyanins, the pigments responsible for the reddish colouring of fruits.

What are the advantages of applying AminoQuelant-K:

- **Improved coloration.**
- **Earlier ripening.**
- **Increased calibre.**
- **More homogeneity of the fruit.**
- **Increased nutritional value.**
- **Greater mineral content.**
- **Improved firmness.**
- **Improved flavour.**
- **Healthier fruit.**



AminoQuelant-K. Physiological functions.

Activation of enzymes and protein synthesis:

- Potassium participates in the activation and stimulation of more than 50 vegetable enzymes. It is indispensable in the enzymatic processes for synthesising starch, proteins and in the active transport of substances across membranes.
- The main components of enzymes and proteins are L-α-Amino Acids and they must be present in large amounts for correct formation.

Regulation of Stomata and Photosynthesis:

- The accumulation of Potassium and L-α-Amino Acids in the cytoplasm of the guard cells induces the opening of the stomata by increasing the osmotic pressure and the entry of moisture. Closure of stomata is brought about by Potassium leaving cells and causing a corresponding loss of turgidity of the guard cells.
- Several Amino Acids intervene directly in the opening and closing of the stomata, mainly glycine, lysine, proline, tryptophan, phenylalanine, methionine and glutamine.
- Opening of stomata permits the flow of gases and water required for photosynthesis and absorption of water and solutes from roots to leaves through the transpiration current. In situations of hydric and saline stress, the regulation of the stomata is an important factor to preserve water while maintaining a minimum flow of gases.
- Potassium stimulates the binding of CO_2 and, together with Amino Acids, plays an important role in increasing photosynthesis and photorespiration, while contributing to reduce nocturnal respiration and favouring the production of photosynthates.

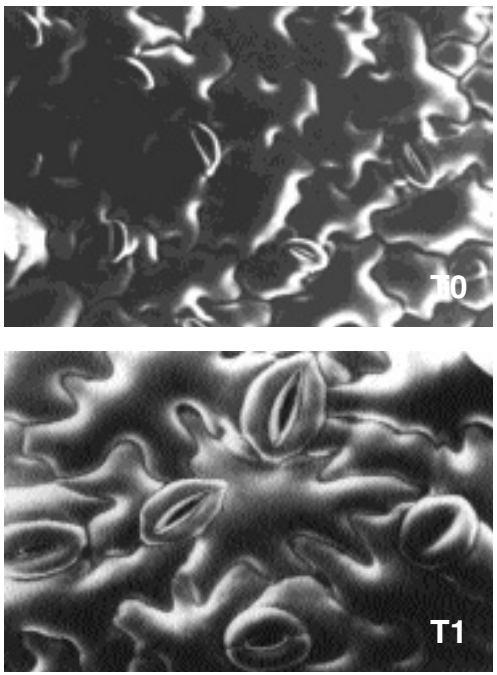
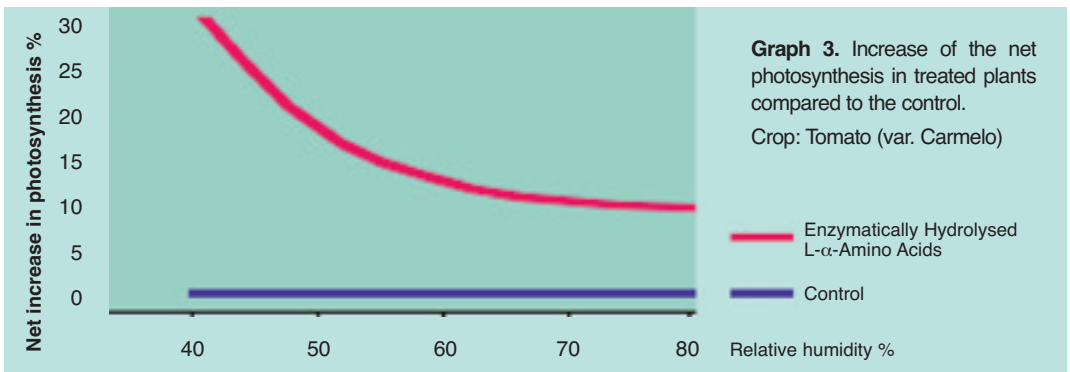


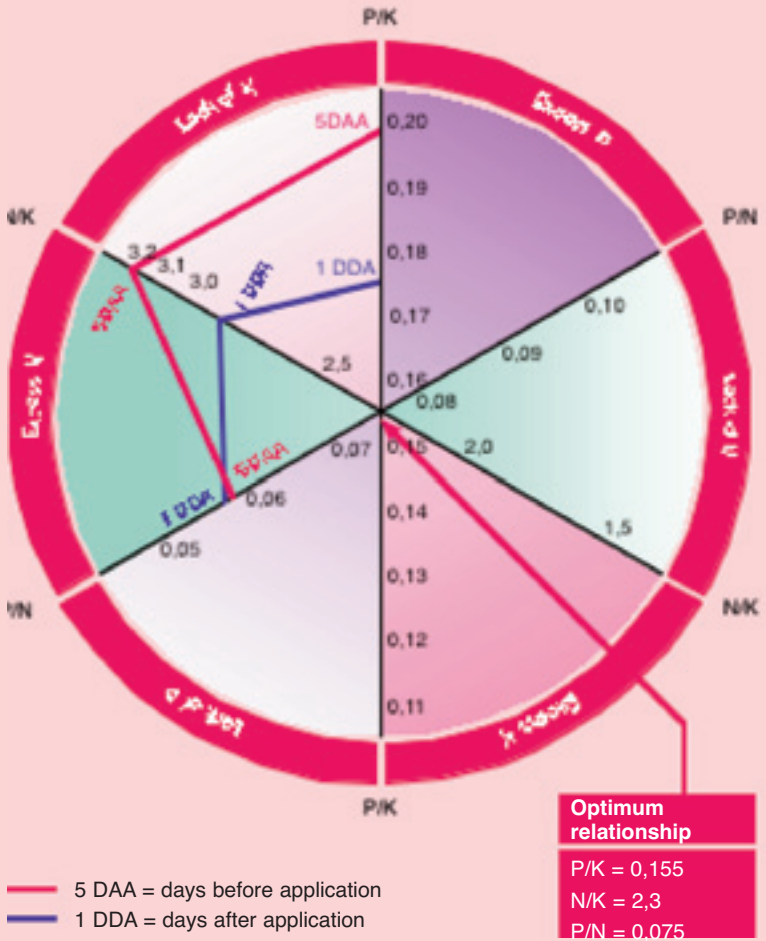
Figure 4. Tomato stomata leaves (var. "Carmelo") grown in low relative humidity, with no application (T0) and with aplication of L-α-Amino Acids from Enzymatic Hydrolysis (T1).



Graph 3. Increase of the net photosynthesis in treated plants compared to the control.

Crop: Tomato (var. Carmelo)

Nutritional relationship. Eating grapes. Italia Variety.



Graph 4. AminoQuelant-K, in addition to providing Potassium and Amino Acids, also contributes to the nutritional balance of the crop. Ref. 10 trials using eating grapes. Mineral content in leaves.

Regulation of the pH, the Osmotic Pressure and the Transport of Solutes:

The fact that Potassium and Amino Acids are mobile charges provides them with a series of physiological properties related to osmotic pressure, pH and transport of solutes:

● Maintenance of cell turgidity and cell growth:

The capacity of Potassium to regulate osmotic pressure within the cytoplasm and the vacuoles, favours maintenance of cell turgidity required for cell growth, as well as new growth (buds and fruit). Amino Acids are naturally accumulated in growing organs where demand is higher.

Mineral content	Control	Standard	AQ-K
K (%)	1.67 a	1.66 a	1.92 b
P (%)	0.14 a	0.16 b	0.15 b
Ca (%)	0.05 a	0.06 a	0.06 a
Mg (%)	0.085 ab	0.083 a	0.093 b
Fe (ppm)	23.51 a	39.05 b	43.45 b
Cu (ppm)	7.05 a	7.10 a	9.92 b
Zn (ppm)	7.40 a	7.75 a	9.13 b
Mn (ppm)	4.29 a	4.73 a	4.27 a

Table 1. Mineral content of fruit (peach variety suncrest) after application of AminoQuelant-K (AQ-K) and a standard solution of Potassium.

- **Transport of Nutrients and Photosynthates:**

  The regulation of pH by Potassium plays an important role in favouring the transport of substances across the xylem and the phloem as well as in the activation or deactivation of enzymes.

  Potassium intervenes in the transport of photosynthates, mainly sugars, because it increases osmotic pressure and accelerates the flow of the phloem.

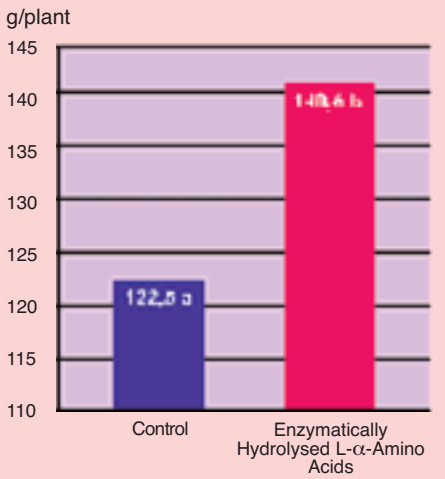
  Free L-α-Amino Acids have an effective complex forming action on ions and increase membrane permeability, favouring the entry of nutrients into the roots and transporting them to different parts of the plant.

Potentiation of the plant's Natural Defences against Stress Situations:

- Plants receiving a correct supply of Potassium are less susceptible to suffer damage caused by low temperatures. Increasing the amount of mineral elements present in the sap also increases the resistance of plants to frosts.
- In cold conditions an accumulation of Amino Acids is observed at the level of cell cytoplasm, specially serine, proline, alanine and arginine, among others. Varieties with a greater capacity to accumulate free Amino Acids also have a better tolerance to low temperature conditions.
- The exogenous application of Amino Acids has a similar effect to natural accumulation, with the added advantage that it allows the plant to save the energy required for synthesis and translocation, energy that will be very necessary for the recovery of the plant when adverse conditions abate.
- Potassium deficiencies involve nutritional imbalances and changes in enzyme activity which are, in part, responsible for a greater susceptibility to the attack by micro-organisms.
- A greater content in Potassium increases cell turgidity making it more difficult for fungi and insects to penetrate.
- It has been observed that the presence of proteins rich in proline confers plants greater tolerance against attacks by fungi.

High efficacy is observed even under adverse conditions.

Trial carried out in a cultivation chamber by the University of Barcelona on application of Enzymatically Hydrolysed L-α-Amino Acids under cold conditions.



Graph 5. Fresh weight of young lettuce plants subjected to cold conditions during 8 days.

L-α-Amino Acids increased the tolerance of the plant to cold, resulting in greater production under adverse conditions.

When and how should AminoQuelant-K be applied?

AminoQuelant-K can be applied to all types of crops through foliar spraying or fertirrigation. It is specially indicated for crops such as vegetables, potatoes, stone fruits, pip fruits, grapes, citric fruits, tropical fruits, olives, etc.

The recommended doses for application are:

- ***Foliar application: 200-400 ml/hl (2-4 l/ha)***
- ***Radicular application: 8-12 l/ha***

In the event of serious deficiencies or stress conditions, the dose should be increased.

The quality of the fruit (colouring, firmness, sugar content, etc.) is improved by application during the second half of the cycle after the fruit has budded, every 10-20 days depending on the crop.

Compatibility:

May be mixed with the majority of fertilisers, fungicides and insecticides. However, the basic pH of the product makes it necessary to check the efficacy of the products being mixed with; a pH corrector may be added to the application solution. Please consult the technical service department or make a previous test in case of doubt.

Do not mix with substances containing large amounts of Calcium or Magnesium.

Recommended doses and application times for different crops:

Culture	Dose	Application
Leafy vegetables (lettuce, broccoli, celery, cauliflower...)	**Foliar spray:** 300-400 ml/Hl. Every 2-3 weeks. **Drip irrigation:** 10-12 l/Ha. 1-3 times a month up to 40 l/Ha.	From 6-8 weeks after transplant until 10 days before harvest.
Fruit vegetables (tomato, pepper, strawberry, cucumber, melon, zucchini, watermelon...)	**Foliar spray:** 200-350 ml/Hl. Every 2-3 weeks. **Drip irrigation:** 10-12 l/Ha. 2-4 times a month up to 60 l/Ha.	From the formation of the first fruit until ripeness.
Citric and fruit trees (Orange, mandarin, lemon, apple, pear, peach, nectarine, kiwi, almond, plum, cherry...)	**Foliar spray:** 200-400 ml/Hl. Every 7-10 days. **Drip irrigation:** 40-70 ml/tree. Every 7-15 days.	From growth of the fruit until harvest.
Vines - Trellised	**Foliar spray:** 300-400 ml/Hl. **Drip irrigation:** 5-10 l/Ha. Weekly.	From development of the fruit until ripeness.
Tropical Fruit (all types of banana, avocado, pineapple, papaya, guava...)	**Foliar spray:** 300-400 ml/Hl. **Drip irrigation:** 50-100 ml/tree. Every 2-3 weeks.	From flowering until ripening of the fruit.
Olives	**Foliar spray:** 350-400 ml/Hl. **Drip irrigation:** 60-100 ml/tree. Every 3-4 weeks.	From growth of the fruit until onset of ripening.
Ornamental plants	**Foliar spray:** 200-300 ml/Hl. Every 7-15 days.	Start before flowering.
Industrial and extensive (potato, beet, soybean, tobacco, cotton, cereals...)	**Foliar spray:** 300-400 ml/Hl. Every 3-4 weeks.	From 4-5 weeks after sowing or transplant until harvest.

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