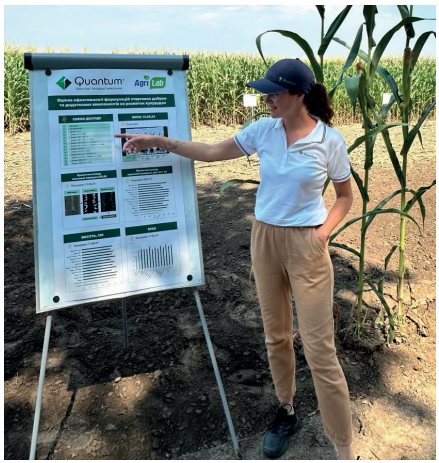
Quantum®
Plant nutrition innovations

AGROVIO Alp

PRODUCT CATALOG 2025

EVERY DROP TO GROW YOUR CROP


Quantum
Agri Lab


СПЕЦІАЛЬНЕ РІДКЕ ДОБРИВО
SPECIAL LIQUID FERTILIZER
Quantum®
20л
10л
5л


Quantum
DIGITAL
Внесено за технологією IN-FURROW®
КВАНТУМ ДІАФАН АСТіоп 2.0 25 л/га
КВАНТУМ СіАмін 1 л/га
Варіант № 11


Quantum
ДІАФАН
NPK


EVERY DROP
TO GROW YOUR CROP
FOLIAR FERTILIZER
UltraComplex
FOLIAR FERTILIZER
QUANTUM
DIAFAN ACTion
EVERY DROP
TO GROW
YOUR CROP

COMPANY OVERVIEW

RPC “KVADRAT” – Manufacturer of High-Efficiency Fertilizers, Quantum® Brand

A Ukrainian scientific and production company established in 2010. We specialize in the research, development, and production of highly efficient foliar liquid and water-soluble fertilizers, liquid and microgranulated starter formulations, biostimulants, as well as modern plant nutrition technologies.
The leader in Ukraine in the segment of specialty fertilizers.

Key Facts

- **EC Fertilizer:** Since 2016, the QUANTUM product line has been registered in the EU and is designed to ensure crop production at all stages of plant development, using an individualized approach tailored to specific growing conditions across the diverse climatic zones of the European Union.
- **Export:** Current deliveries to several EU countries — Czech Republic, Slovakia, Germany, Romania.
- **Quality System:** ISO 9001:2015 (R&D, production, fertilizer sales).
- **Production:** State-of-the-art production lines for liquid chelated micronutrient fertilizers and other complexes, premium-class liquid starter fertilizers and biostimulants, using high-quality raw materials, scientific research, and developments based on practical “field experience”; microgranule production line (first in Ukraine since 2018).
- **R&D:** Opening in 2024 of the QUANTUM R&D Center with analytical laboratories (ICP-OES spectrometer, UV-Vis spectrophotometer, XRF equipment for heavy metal content analysis).

- **Technologies:**
  - **IN-FURROW®/POP-UP®** – application of fertilizers into the seed furrow directly on or close to the seed during planting: the most modern and economically optimal technology.
  - **Extra Chelate** – protection of micronutrients from interaction with other fertilizers, biostimulants, and crop protection products in tank mixes or soil, across a wide pH range.
  - **ACTion® (rhizosphere management)** – a technology for intensifying rhizosphere processes, aimed at maximizing the efficiency of root processes and increasing nutrient uptake by plants rather than increasing chemical fertilizer application rates.
  - **ART® (phloem transport)** – a technology that enhances phloem mobility of nutrients, ensuring rapid translocation of elements from the site of application to young plant tissues.
  - **RX® (stress tolerance)** – based on the action of a range of organic compounds with high biostimulant activity and antistress effects.

Company Mission – implementation of economically viable, modern technologies based on scientific research and development, enabling the choice of optimal and justified solutions for crop cultivation and achieving stable yields under any climatic conditions.

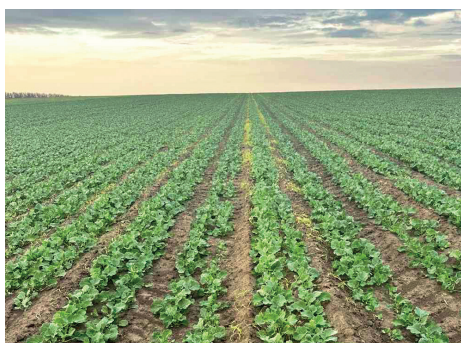
AGROVIO – QUANTUM 2025

Agrovio Alp GmbH – official and authorized representative of RPC “KVADRAT” in EU countries.

The European company of the Agrovio group combines QUANTUM’s factory technologies with many years of field experience.

What we offer to farmers and distributors in the EU:

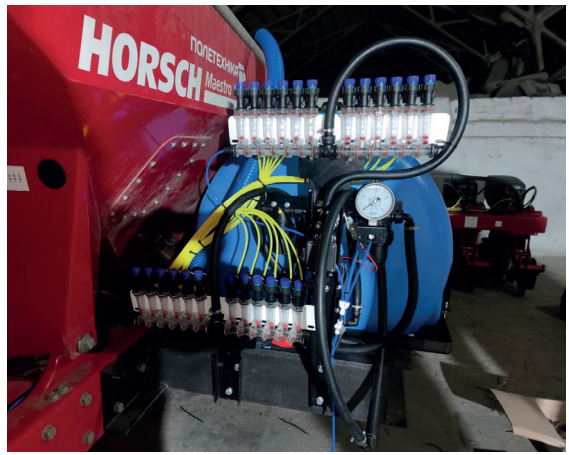
- **Distribution and integration of QUANTUM solutions:** liquid and microgranulated starter fertilizers, micronutrents, biostimulants, adjuvants – a complete portfolio of fertilizers for every stage of plant growth.
- **360° Agronomic Support:** diagnostics, analysis, and development of economically optimal and adapted schemes for crop/soil/climate, efficiency calculations (yield, cost, CO_2).
- **Engineering Solutions IN-FURROW®:** design, installation, and service of liquid starter fertilizer application systems for seeders of any configuration.
- **Training and Standards:** field days, training for agronomists and service teams, SOPs for precise nutrition and tank mixes.
- **Logistics and Compliance:** full delivery cycle from the manufacturing plant to the customer, strict compliance with EU legislation, agronomic and technical support.

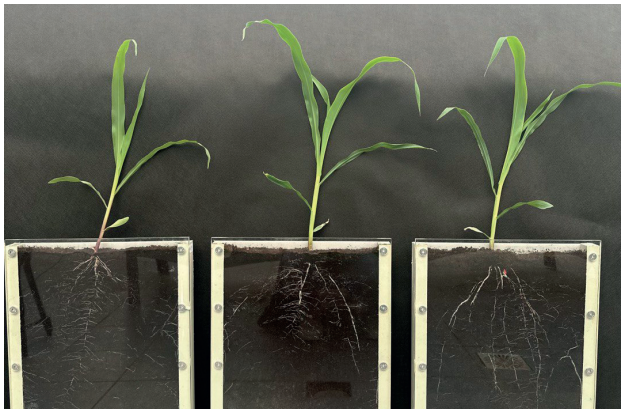


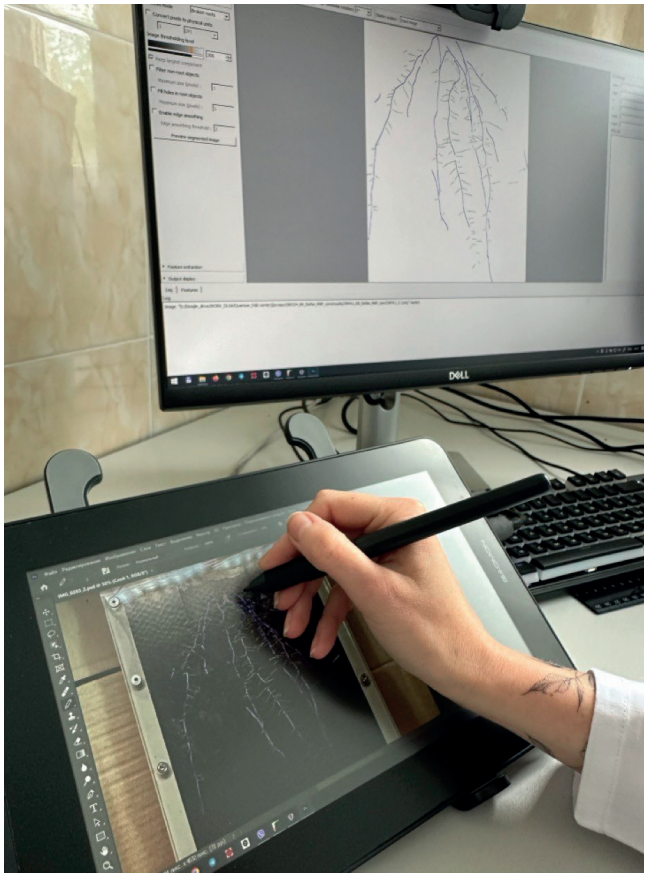
WHY CHOOSE US

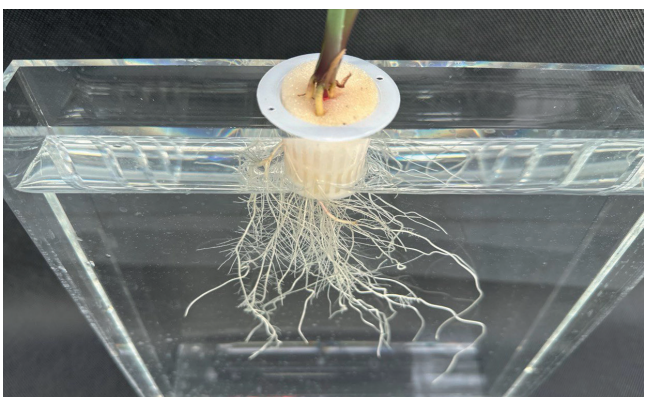
- **Fast Implementation:** economically optimal “from warehouse to field” solutions with ready-to-use application rate and growth stage maps, and action algorithms to achieve effective yields.
- **Precise Economics:** efficiency at low application rates, reducing total costs (TCO).
- **One Responsible Partner:** combination of proven practical solutions, scientific developments, technologies, engineering, and agronomic support.
- **Official Status:** Agrovio Alp GmbH is the official and authorized representative of RPC “KVADRAT” in the EU countries for promoting QUANTUM products, implementing technologies, and developing the distribution network.

Quantum®
Plant nutrition innovations









REASEARCH AND INNOVATION

In 2024, RPC «KVADRAT» embarked on a new stage of development by expanding its research division and opening the new **R&D Center QUANTUM**.

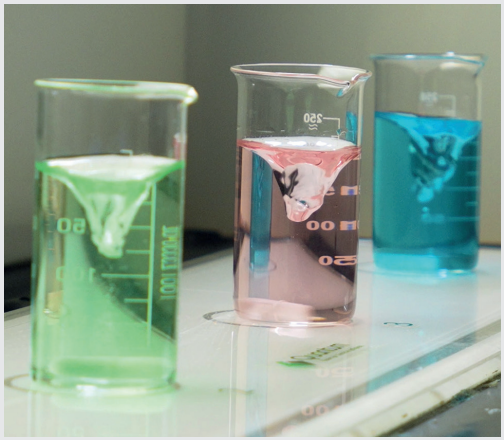
The new research unit is based in the suburbs of Kyiv and focuses on discovering innovative and efficient solutions in plant nutrition. The primary emphasis is placed on studying the effectiveness of new substances and technologies, developing and testing new products on various agricultural crops under different conditions, including soil property changes, stress factors, and more.

Product efficacy analysis is conducted using both invasive and non-invasive plant phenotyping methods. This includes assessing root system development and monitoring throughout the growing season using rhizoboxes, root image scanning, and analysis software. RGB image segmentation technologies are used to evaluate parameters such as plant height and leaf area. Additionally, biochemical parameters such as chlorophyll content and the chemical composition of plant tissues are analyzed.

Experimental product formulations are evaluated using advanced research methods, scientific standards, and protocols to ensure accuracy and reliability.

LABORATORY

Modern technologies of plant growing require effective and reasonable use of fertilizers. One of the instruments to optimize the plant nutrition system is a contemporary plant leaf diagnostics held in time. This allows to carry out nutrition of plants according to their needs. We perform direct measurements of nutrients in plant leaves (this methodology has been realized in leading agrochemical laboratories) and on the base of these data, we provide recommendations for adjustment of plant nutrition, applying up-to-time devices and equipment, produced by leading manufacturers such as Thermo (ICP-OES and Vis-UV spectrometers).



MAXIMIZING THE EFFICIENCY OF FERTILIZER APPLICATION

Finding ways to maximize plant productivity while minimizing input costs is the key to the economic efficiency of agricultural production.

Therefore, developing an effective and rational fertilization system should be based on understanding the processes occurring in the soil and plants, knowledge of nutrient interactions, and the factors influencing nutrient availability and mobility in the soil and their absorption by crops. Additionally, it is crucial to properly assess the potential effectiveness of different types of fertilizers under specific conditions and to select appropriate timing and application methods.

The reasons for nutrient deficiencies are linked to two main factors:

- Insufficient nutrient content in the soil.
- Temporary limitations on nutrient availability in the soil or disruptions in plant absorption due to changing weather, climate, and soil conditions.

Understanding the factors limiting nutrient availability helps develop and adjust crop nutrition plans, ensuring the maximum realization of their genetic potential. Rational foliar fertilization with fertilizers and biostimulants not only helps plants prepare for stress factors but also enables them to overcome their consequences.

FACTORS LIMITING NUTRIENT AVAILABILITY

HIGH pH
P, Mg, Fe, Mn, Zn, Cu, Co, B

LOW pH
P, K, S, Mo

DROUGHT
K, N, Ca, B, Mn, Zn, Cu, Mo

LOW TEMPERATURE t°
N, P, S, Zn, Mn, Fe

POOR AERATION (compaction, flooding)
N, Cu, Zn, Mn, Fe

LIMING
B, P, K, Mg, Fe, Zn, Mn

SANDY SOILS
B, K, N, Mo, S, Mg, Cu, Mn, Zn

ORGANIC SOILS (peatlands, organic fertilizers)
Cu, Zn, Mn, Fe

RULES FOR CREATING AN EFFECTIVE PLANT NUTRITION SYSTEM

To maximize fertilizer efficiency and avoid possible negative environmental impacts, the International Plant Nutrition Institute (IPNI) developed the **4R Nutrient Stewardship Strategy**. The **4R principles** are based on four key rules for fertilizer selection and application:

1. **Right fertilizer type;**
2. **Right application timing;**
3. **Right application rate;**
4. **Right application method.**

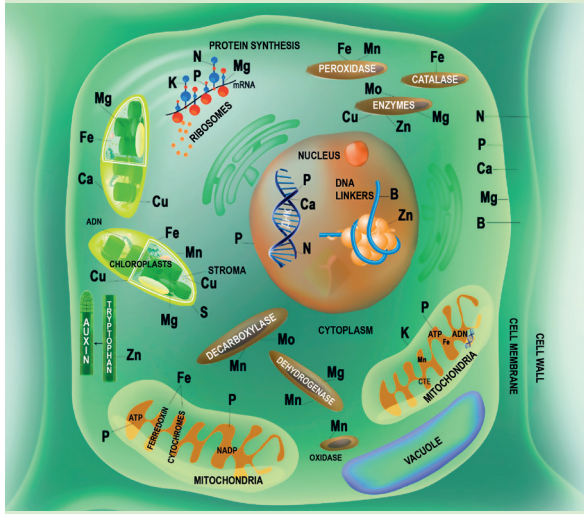
4 nutrient stewardship

These principles are applicable to various farm types, farming systems, and soil-climate conditions. However, it is important to understand their interconnection: each of the four principles requires a proper selection of the remaining three, and none of them can be fully effective without considering the others.

RPC «KVADRAT», with extensive practical experience and deep knowledge in plant nutrition physiology, has developed a range of fertilizers and biostimulants that allow for the fullest realization of any crop's potential.

CONDITIONS FOR MAXIMUM FERTILIZER EFFICIENCY

THE ROLE OF NUTRIENTS AT THE CELLULAR LEVEL



N (Nitrogen) – Key component of proteins, enzymes, chlorophyll, and nucleic acids.

P (Phosphorus) – Essential component of nucleic acids (DNA, RNA), necessary for energy transfer.

K (Potassium) – Activates the ripening process, important for mitochondrial and cell membrane permeability.

Ca (Calcium) – Structural component of the cell wall, necessary for chromosome integrity, cell membrane stability, and cell division.

Mg (Magnesium) – Structural component of chlorophyll, necessary for nucleic acid synthesis.

S (Sulfur) – Major component of certain amino acids, vitamins, and proteins.

Fe (Iron) – Component of cytochromes for respiration, involved in chlorophyll synthesis and electron transport.

Mn (Manganese) – Activates photosynthetic enzymes, essential for chlorophyll formation, and activates reactions in the Krebs cycle.

Zn (Zinc) – Plays a role in respiratory enzyme activation, auxin synthesis, and protein formation.

NUTRIENT ROLES IN PLANT DEVELOPMENT

FLOWER FORMATION

Mo - Pollen formation
Cu - Prevents flower drop
B - Pollen germination

LEAF DEVELOPMENT

Mn - Chlorophyll synthesis
Cu - Chlorophyll synthesis
Fe - Photosynthesis

FRUIT FORMATION

Zn - Carbohydrate synthesis
B - Fruit formation
- Sugar synthesis and transport
- Ripening

Cu - Improves organoleptic characteristics of fruits and vegetables

SEED FORMATION

B - Seed initiation
Zn - Seed development

ROOT FORMATION

Fe - Functioning of nitrogen-fixing bacteria
Zn - Initial root growth
Mn - Nitrogen metabolism
Cu - Nitrogen metabolism

STEM FORMATION

Zn - Protein synthesis
- Growth regulation

Fe - Plant growth and development
Cu - Strength of the cell wall

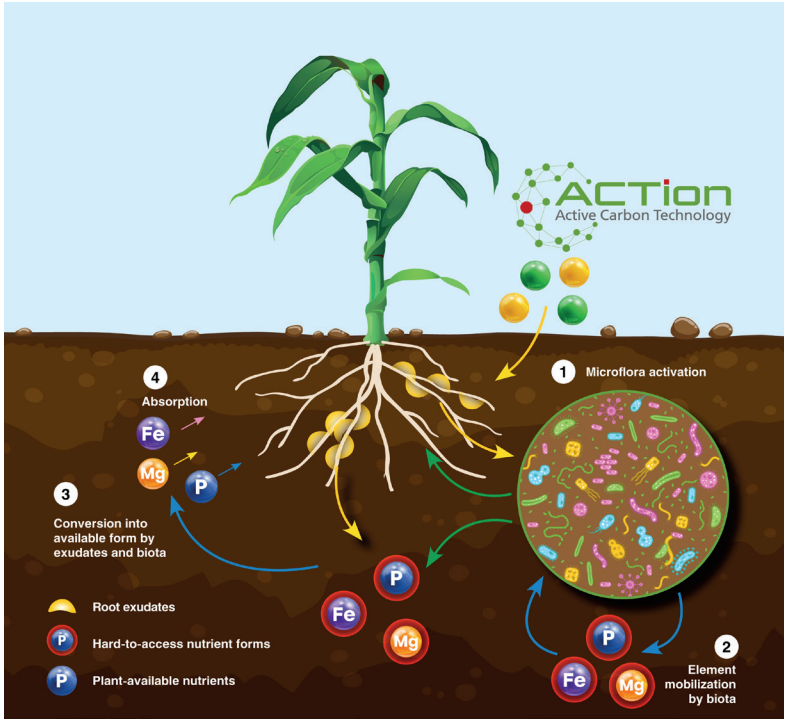
An effective plant nutrition strategy requires:

- **understanding the fundamentals of nutrition:** kowing the role and interactions of nutrients in plants helps identify limiting factors and develop rational fertilization systems.
- **understanding fertilizer behavior in the soil:** predicting fertilizer efficiency and selecting the most suitable forms, timing, and application methods.
- **proactive planning:** modern farmers must anticipate potential deficiencies.
- **proper nutrient balance:** plants absorb nutrients in specific ratios; unbalanced application of a single nutrient can reduce effectiveness or worsen deficiencies of others due to nutrient antagonism.
- **maximizing fertilizer efficiency (nutrient use efficiency):** correct consideration of all factors and implementation of the 4R Strategy ensures the highest agronomic and economic benefits of fertilizer application.

Active Carbon Technology – Rhizosphere Process Intensification Technology (Rhizosphere Management)

The technology is based on the concept of rhizosphere management — regulating the soil zone around the roots, the soil zone surrounding the roots, which is closely interconnected with root exudates and soil microbiota (bacteria, fungi, and other organisms).

The concept focuses on maximizing root process efficiency and increasing nutrient uptake efficiency by plants rather than increasing fertilizer application rates.



The ACTion complex, due to its biological activity, mimics plant root exudates that stimulate rhizosphere processes:

- enhances microbial activity in the soil and improves nutrient absorption;
- provides an accessible energy source (carbon) for soil, microbiota, and crops;
- stimulates root system development;
- activates stress resistance at early growth stages;
- buffering agents in ACTion promote phosphorus and other nutrient mobilization from the soil and applied fertilizers.

Root-Rhizosphere Microflora System
The root-rhizosphere microflora begins forming immediately after seed germination. The application of Quantum DIAFAN starter fertilizers with ACTion technology at sowing promotes:

- active colonization of the root zone even before seed germination and stimulation of microbiota multiplication and activity, even under unfavorable conditions;
- improved nutrient availability through both the direct impact of ACTion components on the mobility of hard-to-access nutrients and the indirect stimulation of rhizosphere microbiota activity in the root system.

Specialized liquid and microgranular fertilizers designed for application during the sowing (or planting) of various agricultural crops using **IN-FURROW®** technology.

The primary goal is to meet the nutrient demands of seedlings with readily available elements during the early growth stages when the root system is still underdeveloped, especially under unfavorable conditions..

IN-FURROW® Technology

The application of fertilizers, crop protection products (CPPs), microbial inoculants, growth regulators, and other inputs directly into the seed furrow or in close proximity to the seed during sowing.

POP-UP® Technology

A subtype of IN-FURROW® technology, where fertilizers are applied at sowing either in direct contact with the seed or in close proximity to enhance early nutrient uptake.

A STRONG START PROMOTES

- Faster germination and uniform emergence.
- Development of a well-established root system.
- Enhanced early plant growth.
- Improved resistance to abiotic stress, pests, and diseases.
- Better competition with weeds.
- Earlier flowering before the onset of heat stress.
- More efficient moisture utilization.
- Earlier maturation and reduced grain moisture at harvest, leading to lower drying costs.
- Increased yield, particularly under low early-season temperatures.

Phosphorus – the key element for in-row application
Phosphorus is the most critical element for in-row application at sowing due to its very low mobility in soil and its essential role in early plant development. Nitrogen, potassium, and micronutrients in fertilizers further enhance phosphorus efficiency.

POP-UP® starter fertilizer is most effective under:

- low levels of available phosphorus in the soil and insufficient pre-sowing phosphorus fertilization;
- early spring or late fall sowing, regardless of soil fertility levels;
- low soil temperatures at the beginning of vegetation;
- light, sandy soils;
- sowing after fallow («fallow syndrome») or after non-mycorrhizal crops (e.g., rapeseed, sugar beet);
- no-till and resource-efficient farming technologies;
- soils prone to phosphorus fixation (acidic or alkaline pH, carbonate soils);
- crops and hybrids/varieties with weak or slow root system development;
- irrigated crops and high-yield potential production systems.

Quantum DIAFAN PREMIUM LIQUID STARTING FERTILIZER NPK

20 l, 1000 l

ACTion Active Carbon Technology

When producing Quantum Diafan liquid starter fertilizers includes ACTion — a unique composition of natural plant metabolites and biologically active substances.

Biochemical «Fingerprint»

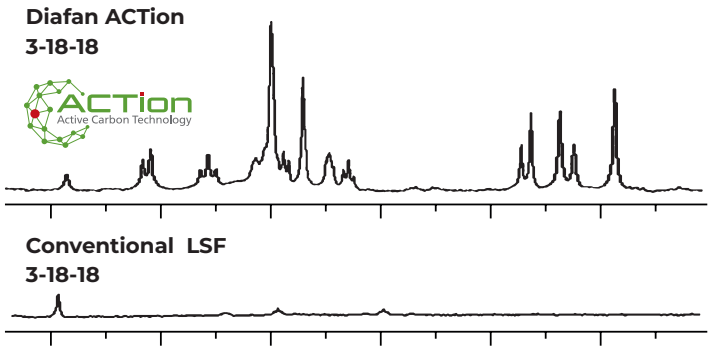
NMR spectral analysis showing well-defined peaks indicates the presence of additional organic stimulating components in **Quantum Diafan ACTion** fertilizer.
Such components ensure high biological activity on soil microflora and agronomic efficiency when used as a starter fertilizer.

QUANTUM DIAFAN ACTion

High-purity, concentrated macronutrient compositions designed for maximum starter effect and to provide plants with essential nutrients.

Advantages

- 100% available ortho-phosphate form of phosphorus.
- Reduced sensitivity to drought conditions.
- Effective absorption at low soil temperatures.
- High efficiency at low application rates.
- No ballast salts (chlorides, etc.) or harmful impurities.
- Safe for plants when applied at optimal rates.
- Neutral pH level.
- Low salt index (safe for seedlings and leaves).
- No equipment corrosion.
- Low crystallization temperature.
- Excellent compatibility with micronutrients, pesticides, and biostimulants.



Comparison of NMR Profiles of Liquid Starter Fertilizers.

Quantum Diafan ACTion	5-20-5	3-18-18
Composition, g/L		
Total Nitrogen (N)	64	42
Including ammonium nitrogen ($N\text{-}NH_4^+$)	64	9,8
Amide nitrogen ($N\text{-}NH_2$)	-	32,2
Available phosphorus (P_2O_5)	254	252
Available potassium (K_2O)	64	252
Complex of biologically active substances – ACTion	14	14
Properties		
Density (at 20 °C), g/mL	1,25 – 1,28	1,37 – 1,41
pH, units	6,5 – 7,0	7,3 – 7,7
Crystallization point, °C	-12,7	-18,2

Soil Application (In-Furrow® Technology). Application rate: 20-90 L/ha (25-125 kg/ha).
Corn, sunflower, soybean, sugar beet: 20-50 L/ha (25-70 kg/ha).
Cereal crops, rapeseed: 30-90 L/ha (55-125 kg/ha).
The safe maximum application rate for seeds and seedlings depends on the crop type, row spacing, soil texture, temperature and moisture conditions, cation exchange capacity, organic matter content, applicator design, and other factors.

Foliar Feeding. Recommended application rate: 3–7 L/ha.
Follow all guidelines for effective foliar fertilizer application. Mixing the fertilizer with hard water may cause precipitation—use water softening agents if necessary.

Seed Treatment. Quantum Diafan ACTion fertilizers can be used for pre-sowing seed treatment in combination with seed treatment products, micronutrients, and biologically active substances at a rate of 1–3 L per ton of seed.

Fertigation. To prepare the irrigation mixture, dissolve 5 L of fertilizer in at least 1000 L of water.
The total fertilizer consumption during the growing season typically ranges from 50 to 100 L/ha.
The daily application rate varies from 1 to 10 L, depending on crop type and agronomic needs.


Quantum®
Plant nutrition innovations
LISTOVÉ HNOJIVO
UltraZinc 117
LISTOVÉ HNOJIVO
SeaAmin
pomocný rostlinný přípravek

QUANTUM® FOLIAR FERTILIZERS — AVAILABLE NUTRIENTS FOR YOUR CROPS.

Quantum® foliar fertilizers offer a fast and efficient way to supply plants with essential nutrients required for their optimal growth and development. Our product portfolio includes not only foliar fertilizers that deliver both macro- and micronutrients but also special plant products that help crops to cope with stress factors such as drought or or chemical stress (e.g., from pesticides). The individual micronutrients are in water-soluble or chelated forms to ensure maximum availability and easy plant absorption.

FOR NUTRIENT SUPPLEMENTATION:

- **Quantum® BoronActive**
- **Quantum® UltraComplex**
- **Quantum® UltraZinc 117**

FOR STRESS RESILIENCE:

- **Quantum® AquaSil**
- **Quantum® AminoMax**
- **Quantum® SeaAmin**

Values g/l	Quantum® BoronActive	Quantum® UltraComplex	Quantum® UltraZinc 117	Quantum® AquaSil	Quantum® AminoMax	Quantum® SeaAmin
Total Nitrogen (N)	61	99			min. 24	min. 70
Phosphorus as water-soluble P_2O_5		99			min. 22	min. 70
Potassium as water-soluble K_2O		87		100	min. 23	min. 70
Iron (Fe) in EDTA chelate		0,6			0,55	
Manganese (Mn) in EDTA chelate		0,4			0,55	
Copper (Cu) in EDTA chelate	0,4	0,3			0,55	
Zinc (Zn) in EDTA chelate		0,3	117		0,55	
Boron as water-soluble B	148	0,2			0,27	
Molybdenum as water-soluble Mo	0,4	0,06			0,11	
Water-soluble Cobalt (Co)					0,05	
Silicon (Si) as SiO_2				200		
Amino Acids					min. 200	
Total Organic Carbon (TOC)					min. 110	min. 70
Seaweed Extract						210
Humic Substances				13		

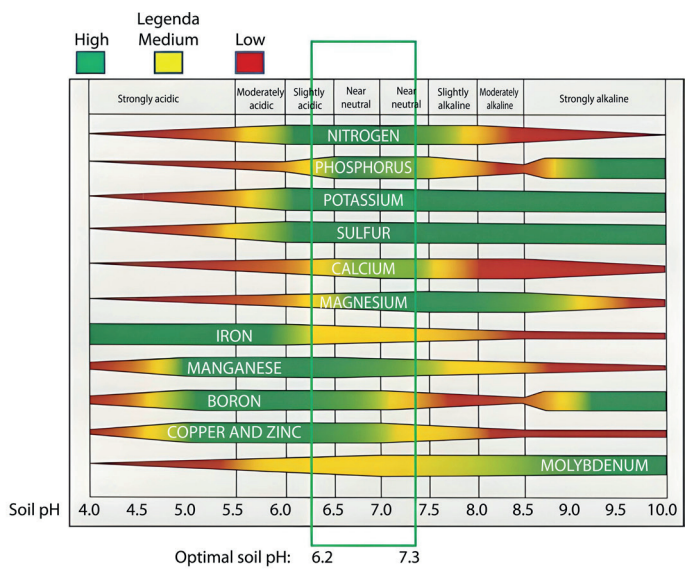
FOLIAR FERTILIZERS AND THEIR IMPORTANCE

Fertilization is one of the most effective methods for influencing plant productivity and crop quality. Foliar fertilizers have been used in crop production for many years, especially in intensive farming technologies. The reason is that foliar application provides the most efficient nutrient uptake compared to soil fertilization. Studies show that achieving the same effect with soil-applied fertilizers requires significantly higher doses compared to foliar application (see table on the right).

Foliar application is particularly effective in the case of micronutrients. The efficiency is significantly influenced by the form in which the elements are present in the product. The most effective is the chelated form, in which the trace element is bound to an organic acid. Scientific studies report that the efficiency of chelates is up to 5–10 times higher than that of salts. Both macronutrients (N, P, K, S, Mg, and Ca) and micronutrients (Fe, Mn, Zn, Cu, B, Mo, Co, Ni, etc.) are essential for plant nutrition. A deficiency of any nutrient can negatively affect plant growth and their ability to overcome abiotic and biotic stress factors.

The nutrient utilization rate from the soil is low — for nitrogen fertilizers it ranges from 60 to 90 %, for phosphorus depending on the soil type from 8 to 30 %. For micronutrients, the uptake rate can be less than 1 %. Based on this, conclusions can be drawn regarding the importance of foliar nutrition in crop production.

Effect of soil pH on nutrient availability for plants



Required dose for foliar vs. soil application		
Element	**Foliar Application**	**Soil Application (In-Furrow®)**
Nitrogen (N)	1	4 -15
Phosphorus (P)	1	20
Potassium (K)	1	6
Sulfur (S)	1	5-7
Magnesium (Mg)	1	75
Calcium (Ca)	1	35-40
Iron (Fe)	1	25-100
Manganese (Mn)	1	30
Copper (Cu)	1	12
Zinc (Zn)	1	12
Boron (B)	1	30

Firstly, the content of elements in the soil, determined based on soil sample analysis, cannot be considered fully available to plants under field conditions. The individual forms of elements are not equivalent — some forms are more readily available, while others are completely unavailable for plant uptake through the soil.

Secondly, even elements that are typically available for plant uptake through the root system may, in certain cases, become inaccessible. This limitation depends on the properties of the soil. For example, in soils with an acidic pH, molybdenum is almost unavailable to plants, while manganese and zinc are poorly absorbed from alkaline soils. Boron is difficult for plants to absorb from dry soils or, conversely, from excessively wet soils.

The availability of elements through the soil is influenced not only by weather conditions and climate changes but also by the chemical and physical characteristics of the soil. Micronutrients applied directly to the leaf surface easily penetrate into the plant tissues, are well absorbed, and quickly utilized.

In foliar application, macro- and micronutrients directly participate in the synthesis of organic matter in the leaves or are transported to other parts of the plants where they contribute to metabolic processes. Foliar nutrition is usually more effective than fertilization through the soil, as nutrients in mobile forms are more readily absorbed.

Timely foliar application of fertilizers allows providing plants with macro- and micronutrients during critical growth stages when the plant needs them the most. It also reduces the effects of stress caused by adverse environmental factors, prevents the development of diseases due to deficiencies of certain elements, and thus creates optimal conditions for plant growth and development.

It should be noted that foliar nutrition should be considered as a supplement to soil fertilization, not as its replacement.

Plants are capable of effectively absorbing nutrients through the leaf surface only in a limited amount, exceeding which may cause damage to the leaf area and plant intoxication.

Foliar nutrition increases chlorophyll synthesis in the leaves, which promotes a more intense green color. Increased photosynthetic activity, in turn, stimulates root growth, with root hairs excreting more sugars, supporting the growth of microorganisms that ensure the synthesis of auxins and other substances stimulating root development. As cell exchange increases, moisture absorption by roots is enhanced, thereby improving nutrient uptake from the soil solution. Thus, foliar nutrition activates the plant's «pumping system» and increases nutrient absorption from the soil.

Micronutrients and their importance for plants

Element	Importance for the Plant	Symptoms of Deficiency
Boron (B)	Affects carbohydrate metabolism and transport; promotes cell wall synthesis and lignification.	Morphological changes (death of terminal buds, elongated internodes), chlorosis of young leaves
Manganese (Mn)	Participates in the photosynthesis process	Leaf chlorosis, growth limitation
Copper (Cu)	Participates in many redox reactions	Gradual dieback of apical leaves, drying and yellowing, growth suppression, loss of turgor and wilting
Molybdenum (Mo)	As a component of enzymes, it participates in nitrogen metabolism and acts as an electron carrier	Yellow color in the center of the plant and old leaves, small leaves with necrotic spots
Zinc (Zn)	Essential component of more than 300 enzymes involved in carbohydrate, nitrogen, and amino acid metabolism	Yellow color in the center of the plant and old leaves, small leaves with necrotic spots mainly on young plant parts, formation of rosettes with small and narrow pale green leaves, shortened internodes
Iron (Fe)	An essential component, involved in redox processes, contributes to chlorophyll synthesis	Leaf chlorosis

Sources:
Multimedia educational texts on plant nutrition, Prof. Ing. Rostislav Richter, DrSc.
Trace elements in plant nutrition, Ing. Marie Trčková, Mgr. Ivana Raimanová

1 l, 5 l, 20 l

Quantum® BoronActive

Highly effective fertilizer containing bioavailable, biologically active forms of boron. The amino acids in the formula enhance boron absorption through the leaf surface, stimulate metabolism, and increase the plant's stress resistance, which is particularly important during the critical generative development phase. Additionally, it is enriched with a complex of polyols, which promote the effective remobilization of boron through the phloem to growth points and young plant tissues.

Soil Application (In-Furrow® Technology):
It can be used in combination with liquid starter fertilizers such as Quantum® DIAFAN at a dose of 0,5–1,0 l/ha.

CHEMICAL COMPOSITION AND PROPERTIES wt% (w/v):	
B	10,9% (148 g/l)
N	4,5% (61 g/l)
Cu in EDTA chelate	0,03% (0,4 g/l)
Mo	0,02% (0,4 g/l)
pH	6,5-8,5
Density	1,30-1,36 kg/l

- Effectively provides Boron (B), which is crucial for nitrogen metabolism and root nodule formation. It also promotes more intense flowering and fertility, carbohydrate metabolism, and protein synthesis.
- Provides Molybdenum (Mo) and Copper (Cu), which improves nitrogen utilization by plants.
- Compatible with most pesticides.

Benefits of using Quantum® BoronActive:

- supports nitrogen metabolism and promotes root nodule formation;
- enhances flowering and fertility, carbohydrate metabolism, and protein synthesis;
- improves flower formation and pollination;
- intensifies sugar accumulation and transport;
- boosts plant immunity;
- increases resistance to fruit and root rot.

Soil (In-Furrow®): 0,5–0,7 l/ha with Quantum® DIAFAN ACTion.

Foliar Spray: 1–3 l/ha for agricultural crops and vegetables in 200–400 l/ha, for vineyards, orchards, and small fruits in 500–1000 l/ha.

Recommended foliar application rates of Quantum® BoronActive (B)

Crop	Growth Stage	Application rate	Water rate
Rapeseed	Autumn application at 4-leaf growth stage: 1–2 l/ha Spring application at the beginning of stem elongation: 2 l/ha Pre-flowering application: 1 l/ha (can be combined with insecticide treatment against pollen beetle)	1 - 2 l/ha	150 - 350 l/ha
Sugar beet	At the 4–6 leaf stage of the crop; in case of severe deficiency, repeat after 14 days at a rate of 1 l/ha	2 l/ha	150 - 350 l/ha
Sunflower	At the 2–3 true leaf stage up to the bud stage; in case of severe deficiency, repeat every 10–14 days	1,5 - 2,5 l/ha	150 - 350 l/ha
Poppy	At the 6–8 leaf stage of the crop	1 l/ha	150 - 350 l/ha
Cereals	From the end of tillering until the appearance of the flag leaf	0,1 - 0,3 l/ha	150 - 350 l/ha
Potatoes	One week after row closure	1 l/ha	150 - 350 l/ha
Lettuce, Brassica vegetables	At the 4–6 leaf stage of the crop; if severe deficiency is detected, repeat after 10–15 days	3 l/ha	150 - 350 l/ha
Strawberries	2 applications: the first at the white bud stage, the second 14 days later	1 l/ha	350 - 500 l/ha
Apple trees, fruit trees	1st application at the pink bud stage until the beginning of flowering	1 - 2 l/ha	500 - 1.000 l/ha
	2nd application after petal fall		
	3rd application after harvest and before leaf fall (2 l/ha)		
Sweet cherries	1st application at the pink bud stage (1 l/ha)	1 - 2 l/ha	500 - 1.000 l/ha
	2nd application after harvest and before leaf fall (2 l/ha)		

When boron deficiency is confirmed through visual diagnosis or plant tissue analysis, apply Quantum® BoronActive every 7–10 days, especially on fruit trees and vegetable crops. For optimal results, use the product in combination with other fertilizers according to the specific nutritional requirements of the crop.

Quantum® BoronActive is compatible with most agricultural products commonly used in crop production. If compatibility has not been previously confirmed, it is recommended to perform a jar test before preparing a tank mix.

1 l, 5 l, 20 l

Quantum® UltraZinc 117 EDTA

Highly concentrated chelated fertilizer containing zinc (EDTA). It is used to prevent and correct zinc deficiency. Demonstrates excellent compatibility with liquid starter fertilizers and complex tank mixtures blends due to EXTRA-chelation technology.

Complete chelation prevents undesirable reactions and nutrient binding with other elements in the soil or fertilizer mixtures.

- 100% chelated form of micronutrients for maximum stability and effectiveness.
- Excellent compatibility with liquid starter fertilizers (orthophosphates) and other highly concentrated.
- Approved for use with herbicides, fungicides, and insecticides.

CHEMICAL COMPOSITION AND PROPERTIES wt% (w/v):	
Quantum ZINC CHELATE (Zn) 117 EDTA	
Zn	11,7% (117 g/l)
pH	5,5-7,5
Density	1,28-1,35 kg/l
Zn cations chelated with EDTA	

EXTRA CHELATE TECHNOLOGY

Fertilizer effect and mode of action

Highly effective product for the correction of both latent and visible zinc (Zn) deficiency:

- ensures fast and efficient zinc uptake;
- rapid normalization of plant metabolism and improved pollination;
- enhanced hormonal balance, stimulation of auxin and vitamin synthesis;
- increased capacity for carbohydrate synthesis and transport;
- supports optimal plant respiration;
- higher sugar content in fruits;
- strengthened plant resistance to adverse conditions.

Seed Treatment. 1-2 L/t for cereal, legume, industrial, and vegetable seeds.

Soil Application (In-Furrow® Technology). Can be applied together with Quantum Chelated Zinc (Zn) 117 EDTA and Quantum Diafan liquid starter fertilizers at a rate of 1-3 L/ha.

Fertigation. Effective in drip irrigation systems. Application rate: 100 ml per 1 m³ of water.

Recommendations for foliar application of Quantum® UltraZinc 117 EDTA

Crop	Growth Stage	Application rate	Water rate
Corn	2–3 treatments starting from the 3–5 leaf growth stage at 2–3 weeks intervals	0,8 - 1,6 l/ha	150 - 350 l/ha
Cereals	2–3 treatments from the beginning of tillering to mid-stem elongation at 2–3 weeks intervals	0,6 - 1,0 l/ha	150 - 350 l/ha
Root Crops	2–3 treatments from the 5–10 leaf growth stage until row closure at 2–3 weeks intervals	0,6 - 1,0 l/ha	150 - 350 l/ha
Potatoes	2–3 treatments with the first application before flowering and the last at the beginning of vine yellowing, at 2–3 weeks intervals	0,8 - 1,6 l/ha	150 - 350 l/ha
Poppy	2–3 treatments from the 6-leaf growth stage to the beginning of flowering at 2–3 weeks intervals	0,6 - 1,0 l/ha	150 - 350 l/ha
Soybean	2–3 treatments from the beginning of flowering at 2–3 weeks intervals	0,6 - 1,0 l/ha	150 - 350 l/ha
Cucumbers, Tomatoes, Peppers	2–3 treatments with the first application before flowering and the last before full fruit maturity at 2–3 weeks intervals	0,6 - 1,0 l/ha	150 - 350 l/ha
Lettuce, Brassica Vegetables	2–3 treatments with the first application after planting, followed by applications at 2–3 weeks intervals	0,4 - 0,8 l/ha	150 - 350 l/ha
Apple Trees, Fruit Trees	2–3 treatments with the first application before flowering and the last before harvest at 2–3 weeks intervals	0,8 - 1,6 l/ha	500 - 1.000 l/ha
Grapevine	2–3 treatments with the first application before flowering at 2–3 weeks intervals	0,8 - 1,6 l/ha	500 - 1.000 l/ha
Hops	2–3 treatments with the first application before flowering at 2–3 weeks intervals	0,6 - 1,0 l/ha	500 - 1.000 l/ha
Strawberries	2–3 treatments with the first application before flowering and the last before harvest at 2–3 weeks intervals	0,8 - 1,6 l/ha	150 - 350 l/ha

In case of zinc deficiency detected through visual diagnosis or plant tissue analysis, apply Quantum® UltraZinc 117 every 7–10 days (especially for vegetables and horticultural crops).
For improved results, use in mixtures with other fertilizers according to the crop's needs.

Quantum® UltraZinc 117 is compatible with herbicides, insecticides, and most other products that can be used together with liquid fertilizer. Prior to use in a tank mix, perform a compatibility test if compatibility has not been previously confirmed.

5 l, 20 l

Quantum® UltraComplex

Universal liquid foliar fertilizer

Quantum® UltraComplex is a foliar fertilizer containing a balanced ratio of nitrogen, phosphorus, and potassium, as well as a mixture of essential trace elements in chelated and water-soluble form.

CHEMICAL COMPOSITION AND PROPERTIES wt% (w/v):	
N	8,0% (99 g/l)
P_2O_5	8,0% (99 g/l)
K_2O	7,0% (87 g/l)
Fe (EDTA chelate)	0,05% (0,4 g/l)
Zn (EDTA chelate)	1,6% (16 g/l)
Cu (EDTA chelate)	0,025% (0,3 g/l)
Mn (EDTA chelate)	0,03% (0,4 g/l)
B	0,015% (0,2 g/l)
Mo	0,005% (0,06 g/l)
Additionally contains a complex of biologically active substances	
pH	7,0-8,0
Density	1,23-1,28 kg/l

Fertilizer effect and impact

- Corrects trace element deficiencies in all crops when used as part of a balanced fertilization program.
- Trace elements are present in EDTA chelated form – preventing undesirable reactions when mixed with other products.
- The balanced complex of trace elements stimulates key physiological processes in plants during critical growth and development stages.
- Nutrients are in a stable and readily available form, improving their absorption by plants.
- Promotes strong root system formation, enhances photosynthesis, and supports leaf growth without the need for increasing nutrient rates.

Seed Treatment. Dosage: 2–3 L per ton of seed.

Fertigation.
Repeat applications 2–4 times per season at a rate of 1,0–5,0 L/ha of Quantum® UltraComplex.
Filter cleaning of the irrigation system is recommended before and after application due to the presence of organic components in the fertilizer.
After transplanting seedlings, irrigation with a 0.5–0.7% solution is recommended (0,5–0,7 L per 100 L of water).

Foliar Feeding. Dosage: 1,0–5,0 L/ha in 200–400 L/ha of water for cereals and vegetable crops, 500–1000 L/ha for vineyards, fruit, and berries.
Refer to the table below for crop-specific application rates.
Recommended concentration: 0.2% – 1.0%, depending on plant condition and sensitivity.
In early growth stages, use the lower end of the recommended concentration range.
Apply 1–4 times during the season at 8–10-day intervals.

Recommended application rates of Quantum UltraCompex for foliar feeding

Crop	Growth Stage	Application rate	Water rate
Cereals, rapeseed, sugar beet, poppy	2–4 applications at intervals of 2–3 weeks	2 - 5 l/ha	150 - 350 l/ha
Corn	2–3 applications during the growth stage of 3–9 leaves in 2–3-week intervals	3 - 5 l/ha	150 - 350 l/ha
Potatoes	2 applications before flowering, 3–4 applications after flowering at approximately 3-week intervals	3 - 5 l/ha	150 - 350 l/ha
Cucumbers, tomatoes, peppers	2 applications before flowering, 3–4 applications after flowering at approximately 2-week intervals	4 - 5 l/ha	150 - 350 l/ha
Lettuce, brassica vegetables	4 applications, first after transplanting, then at approximately 10-day intervals	4 - 5 l/ha	150 - 350 l/ha
Carrots	6 treatments at two-week intervals	3 - 5 l/ha	150 - 350 l/ha
Onions	4 applications, first one month after emergence, then every two weeks	4 - 5 l/ha	150 - 350 l/ha
Strawberries	1st: beginning of inflorescence; 2nd: end of flowering; 3rd: after harvest	4 - 5 l/ha	150 - 350 l/ha
Apple trees, fruit trees	1st application at pink bud stage, up to the beginning of flowering	1 - 2 l/ha	500 - 1.000 l/ha
	2nd application after petal fall		
	3rd application after harvest and before leaf fall (2 l/ha)		

Quantum® UltraComplex is recommended for foliar fertilization when there is a need to supplement a balanced spectrum and volume of nutrients in both field crops and permanent crops – especially under conditions of intensive growth, ripening, or after overwintering. It is also recommended in autumn for perennial crops with high nutrient demands. Quantum® UltraComplex is also applied in situations where crops are under stress and require special attention.

Quantum® UltraComplex is applied either on its own or in tank mixes with commonly used plant protection products, in accordance with their valid registration. When using in mixtures, consultation with the manufacturers of these products is recommended, along with performing a compatibility test and strictly following the instructions on product labels and accompanying leaflets. Maintain an interval of at least 8–10 days between individual applications.

5 l, 20 l

Quantum® AquaSil

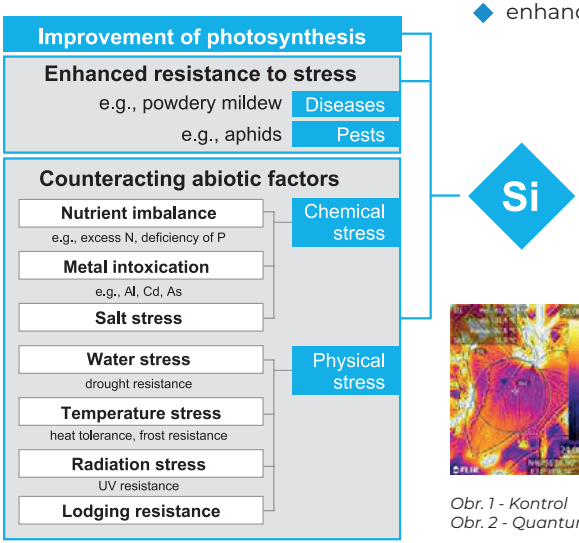
High-concentration complex fertilizer designed for foliar feeding of agricultural, vegetable, fruit, and ornamental crops. It contains a special formulation of silicon and potassium enriched with biologically active substances for improved absorption.

CHEMICAL COMPOSITION AND PROPERTIES wt% (w/v):	
SiO_2	16,0% (200 g/l)
K_2O	8,0% (100 g/l)
Enriched with a complex of biologically active substances	
Density	1,20-1,25 kg/l

Effects and benefits of the fertilizer

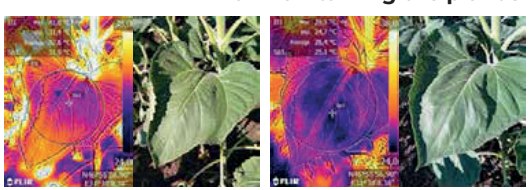
This fertilizer is used for foliar feeding of agricultural, vegetable, fruit, and ornamental crops to:

- strengthen the cell walls of protective tissues, preventing excessive moisture loss;
- maintain potassium balance in stomatal cells;
- reduce transpiration under drought conditions;
- improve plant cooling during heat stress;
- create additional barriers against pests and diseases;
- strengthen plant stems in dicotyledonous crops and enhance the durability of monocotyledonous crops (cereal grains, corn, forage, and lawn grasses);
- extend the shelf life of fruits;
- enhance plant immunity.



The positive impact of silicon on plant growth and development is based on increasing plant resistance to biotic and abiotic stresses (Source: J.F. Ma, N. Yamaji, 2006).

20–30% of the available silicon in the plant organism may be involved in the process of maintaining the plant's internal water reserve.



Obr. 1 - Kontrol
Obr. 2 - Quantum® AquaSil

At Mykolaiv State University in Ukraine, trials with the product AquaSil were conducted on sunflower crops.
The thermal images on the left illustrate the results – the lighter the color, the higher the temperature.
The left image shows the untreated control, where the average leaf temperature reaches 32.6 °C.
The right image, taken after the application of fertilizer and AquaSil, shows a temperature decrease of 6.2 °C.

Recommended application rates of QUANTUM AQUASIL for foliar feeding

Crop	Growth Stage	Application rate	Water rate
Cereals	Tillering stage Stem elongation stage – may be repeated after 2–3 weeks under dry conditions Soft dough stage	1 l/ha 2 l/ha 1 l/ha	200 - 400 l/ha
Corn	3–5 leaf stage 6–8 leaf stage – may be repeated after 2–3 weeks under dry conditions	1 l/ha 1 l/ha	200 - 400 l/ha
Sunflower	2–3 leaf pairs 5–6 leaf pairs – may be repeated after 2–3 weeks under dry conditions	1 l/ha 2 l/ha	200 - 400 l/ha
Rapeseed, Mustard	From the first lateral shoot and during stem elongation Before flowering – may be repeated after 2–3 weeks under dry conditions	1 l/ha 2 l/ha	200 - 400 l/ha
Soybean, Pea	At the 3–5 trifoliate leaf stage From the first flower bud to the beginning of flowering – may be repeated after 2–3 weeks under dry conditions	1 l/ha 2 l/ha	200 - 400 l/ha
Grapevine	From clearly visible inflorescence to ripening – may be repeated after 2–3 weeks under dry conditions	2 - 3 l/ha	500 - 1.000 l/ha
Vegetables	In critical stages of development under dry conditions before flowering – 2–3 applications at intervals of 3–4 weeks	1 - 1,5 l/ha	200 - 400 l/ha
Grasslands	In critical stages of development under dry conditions – apply at 3–4 weeks intervals	2 - 5 l/ha (20-50 ml/100 m^2)	300 - 1.000 l/ha (5-10 l/100 m^2)
Trees and shrubs (fruit, ornamental, conifers)	In critical stages of development under dry conditions – 2–3 applications per season	30 - 50 ml/10 l of water	Tall trees: 8–10 l per plant, Small trees and shrubs: 5 l per plant

Quantum® AquaSil can be applied together with plant protection products and other fertilizers. When preparing tank mixes, pay special attention to water quality. Compatibility tests should be performed before mixing. The working solution should not form sediment, although slight turbidity is acceptable.
The best results are achieved when used in combination with water conditioners and softeners from the Quantum® ASSISTANT product line.

1 l, 5 l, 20 l

Quantum® SeaAmin

Quantum SeaAmine is a concentrated fertilizer derived from seaweed extract and enriched with biologically active compounds that stimulate plant growth and development. It is used to maintain hormonal balance during critical growth stages, enhance stress resistance, and normalize plant nutrition.

The raw material for **Quantum SeaAmine** is sourced from high-quality concentrated extract of ***Ascophyllum nodosum,*** harvested in the Atlantic Ocean and supplied by **Acadian Seaplants (Canada).**

ACADIAN™ PLANT HEALTH SEA BEYOND

CHEMICAL COMPOSITION AND PROPERTIES wt% (w/v):	
N	5,6% (70 g/l)
K_2O	5,6% (70 g/l)
P_2O_5	5,6% (70 g/l)
Seaweed extract contains	17% (210 g/l)
– carbohydrates (poly- & oligosaccharides)	
– macro- and microelements	
– amino acids	
– phytohormones & hormone-like compounds	
– vitamins	
pH	7,2-7,6
Destiny	1,23-1,28 kg/l

Effects and benefits of the fertilizer

Concentrated fertilizer based on seaweed extract with high content of bioactive substances:

SEAmin

- enhances enzymatic and photosynthetic activity;
- helps plants overcome stress, especially drought and extreme temperatures;
- reduces the negative effects of herbicides, fungicides, and insecticides on crops;
- activates natural plant defense against pathogens;
- stimulates cell division, growth, and differentiation;
- increases fertilizer efficiency;
- boosts crop yields and improves product quality.

Seed Treatment.
Application rate: 1–2 L per ton of seeds (cereals, legumes, industrial & vegetable crops).

Soil Application (In-Furrow® Technology). Application rate: 0,5–1,5 L/ha. Can be combined with liquid starter fertilizers such as Quantum Diafan.

Fertigation. Applied 2–4 times per growing season at a rate of 1,0–5,0 L/ha.
Transplant feeding: 0,5–0,7% solution (0,5-0,7 L per 100 L of water)

Recommended application rates of QUANTUM SeaAmine for foliar feeding

Crop	Growth Stage	Application rate	Water rate
Cereals	Tillering stage Stem elongation stage Waxy maturity stage	0,5 l/ha	200 - 400 l/ha
Corn	3–5 leaf stage 6–8 leaf stage	0,5 l/ha	200 - 400 l/ha
Rapeseed, mustard	From the first lateral shoot and during elongation growth Before flowering During pod formation	0,5 l/ha	200 - 400 l/ha
Sugar beet	Row formation stage Canopy closure stage	0,5 l/ha	200 - 400 l/ha
Potatoes	From lateral shoot formation to full canopy closure From inflorescence development to plant desiccation – apply every 7–10 days	0,5 l/ha	200 - 400 l/ha
Sunflower	2–3 leaf pairs 5–6 leaf pairs	0,5 l/ha	200 - 400 l/ha
Grapevine	Flowering stage Fruit growth stage until cluster closure – apply every 7–10 days	0,5 l/ha	500 - 1.000 l/ha
Tomatoes, peppers	From flowering to fruit ripening – apply every 7–10 days	0,5 l/ha	200 - 400 l/ha
Cucumbers	Leaf growth stage – apply every 7–10 days	0,5 l/ha	200 - 400 l/ha
Apple and pear trees	Flowering and post-flowering Fruit development until harvest – apply every 7–10 days	0,5 l/ha	500 - 1.000 l/ha

Adjuvant & Anti-Stress Application

Applied at 0,2–0,7 L/ha when mixed with insecticides or fungicides.

Mixing & Compatibility

- Quantum SeaAmine can be combined with plant protection products and fertilizers.
- Do NOT mix with copper- or sulfur-containing products, mineral oils, or alkaline solutions.
- Avoid combining with herbicides in early growth stages to prevent increased phytotoxicity to crops and stress resistance in weeds.

1 l, 5 l, 20 l

Quantum® AminoMax

Complex foliar fertilizer and antistress agent with Amino Acids. A comprehensive foliar fertilizer and antistress solution containing a balanced set of macro- and micronutrients, plant-derived L-amino acids, and a complex of biologically active substances.

CHEMICAL COMPOSITION AND PROPERTIES wt% (w/v):	
Amino acids	17,8% (200 g/l)
N	2,1% (24 g/l)
P_2O_5	2,0% (22 g/l)
K_2O	2,0% (23 g/l)
B	0,024% (270 mg/l)
Fe	0,049% (550 mg/l)
Zn	0,049% (550 mg/l)
Cu	0,049% (550 mg/l)
Mn	0,049% (550 mg/l)
Mo	0,010% (110 mg/l)
Co	0,004% (50 mg/l)
Enriched with a complex of bioactive substances	
pH	4,0-5,5
Density	1,10-1,15 kg/l

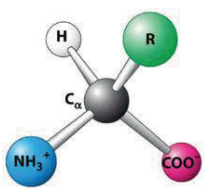
Effects and benefits of the fertilizer

Highly concentrated formulation containing a wide range of amino acids, enriched with macro- and microelements, humic substances, organic acids, and phytohormones to enhance anti-stress effects and boost plant immunity:

- promotes root growth and development;
- helps plants overcome stress, especially under drought and high-temperature conditions;
- stimulates natural plant defense mechanisms against pathogens;
- improves transplant survival rate.

For optimal results, foliar feeding should be combined with other fertilizers according to the crop-specific technological schemes. Not recommended to be applied together with herbicides in early growth stages to avoid enhancing phytotoxicity effects on crops and reducing weed control efficiency.

Amino acids
Amino acids are the fundamental building blocks of all proteins. There are 20 essential amino acids that form all known proteins. Quantum® AminoMax contains 20% L-amino acids (left-handed) with a high (16%) proportion of free amino acids. Amino acids support root system growth, are essential components of plant tissues and chlorophyll, influence water balance maintenance, are easily and rapidly absorbed by plants, and enhance stress resistance..



Seed Treatment. Application rate: 1–2 L/t of cereal, legume, industrial, and vegetable seeds.

Fertigation. Application rate: 1,0–5,0 L/ha, applied 2–4 times during the growing season.
Important: Clean irrigation filters before and after application due to organic components in the product.
Transplant feeding: Watering with 0,5–0,7% solution (0,5–0,7 L per 100 L of water).

Recommended QUANTUM AMINOMAX 200 application rates for foliar feeding

Crop	Growth Stage	Application rate	Water rate
Cereals	Tillering stage Stem elongation stage Wax ripeness stage	0,5 l/ha	200 - 400 l/ha
Corn	3–5 leaf stage 6–8 leaf stage	0,5 l/ha	200 - 400 l/ha
Rapeseed, mustard	From the first side shoot and during elongation growth Before flowering, During pod formation	0,5 l/ha	200 - 400 l/ha
Sugar beet	Row formation stage Canopy closure stage	0,5 l/ha	200 - 400 l/ha
Potatoes	From side shoot formation until the canopy closes From the flower bud formation stage to plant desiccation – application interval 7–10 days	0,5 l/ha	200 - 400 l/ha
Vineyards	Flowering stage Berry growth stage – application interval 7–10 days	0,5 l/ha	500 - 1.000 l/ha
Sunflower	2–3 leaf pairs 5–6 leaf pairs	0,5 l/ha	200 - 400 l/ha
Tomatoes, peppers	From flowering to fruit maturity – application interval 7–10 days	0,5 l/ha	200 - 400 l/ha
Strawberries	From the end of flowering to harvest – interval 7–10 days	0,5 l/ha	500 - 1.000 l/ha
Apple trees, pear trees	Flowering Post-flowering Fruit growth until harvest – application interval 7–10 days	0,5 l/ha	500 - 1.000 l/ha

As an adjuvant & anti-stress agent in tank mix with insecticides and fungicides: 0,2–0,7 L/ha.

NEW POSSIBILITIES FOR REDUCING STRESS IN AGRICULTURAL CROPS WITH QUANTUM® FOLIAR FERTILIZERS

Stress is generally an unfavorable condition induced by external factors. It triggers a stress response, essentially activating defense mechanisms. In plants, stress can be caused by factors such as drought, high humidity, nutrient deficiency, excessive light, low or high temperatures, and others. Stress is often caused by a lack or, conversely, an excess of some essential and common factor (water, oxygen, light, etc.), which is a part of the plant's life cycle. Plants, therefore, possess mechanisms that allow them to cope with stress. Since plants cannot «escape» stress, they are equipped with highly effective defense mechanisms and the ability to regenerate.

Through gradual acclimatization, plants' resistance to stressors can be increased. Generally, the slower the adaptation, the better. It is difficult to predict how quickly cultivated crops will adapt to changing climatic conditions, as well as the extent of their impact on yields, quality parameters, and resistance to diseases and pests.

We distinguish between two main types of stress::

- **Abiotic Stress**
  Caused by a lack of light, water, minerals, carbon dioxide, or oxygen, or by an excess of light, water, or oxygen. It also includes stress induced by high or low temperatures, as well as mechanical stress.
- **Biotic Stress**
  Triggered by pathogens or the action of harmful chemical substances, such as plant protection products, etc.

PLANT STRESSES

ABIOTIC STRESS

- **Drought**
- **Salinity**
- **High / low temperatures**
- **Hail**
- **Light intensity**
- **Heavy metals**
- **Chemical stress**

Up to 80% yield loss

BIOTIC STRESS

- **Bacteria**
- **Viruses**
- **Fungal diseases**
- **Weeds**
- **Pests**

Plants are often subjected to multiple types of stress simultaneously, such as stress from excessive radiation, water shortage, and high temperatures. These individual stress factors can exacerbate each other. For example, stress in crops grown in saline soils is further intensified by water scarcity during droughts. Therefore, anti-stress measures are often combined to address multiple stress factors at once. For instance, wilting is caused by water shortage, but it is also a reaction not only to the lack of water (reduced transpiration) but also to excessive radiation (reducing exposure to sunlight).

Plants often employ **modulatory measures** – immediate changes such as opening/closing stomata, leaf orientation, or changes in the concentration of various substances.

Stress leads to slowing down or even halting growth, making it undesirable from the perspective of agricultural yields. Reducing stress allows for better yields of agricultural crops and plants.

STRESS CAUSED BY LOW SOIL SOLUTION pH

Low soil pH indicates a high concentration of hydrogen ions (protons), which results from the dissociation of acids typically present in acidic soils. These protons displace mineral cations from their bond with negatively charged soil particles. As a result, essential mineral nutrients are leached into groundwater, leading to mineral deficiency-related stress in plants.

HEAT STRESS

High temperatures impair enzyme function and activity due to their narrow optimal temperature range. Excessive heat may irreversibly damage these enzymes and destabilize cell membranes. In response, plants saturate membrane fatty acids and synthesize heat shock proteins (HSPs), which help stabilize protein structure or repair conformational defects.

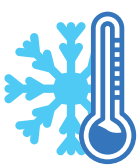
WATER DEFICIT STRESS

Water scarcity may be caused by several factors:

- actual drought in the area,
- high temperatures leading to elevated transpiration and thus significant water loss,
- low temperatures causing ice formation in intercellular spaces. Ice is osmotically active and draws water out of the cells, impairing water uptake.

Plants address water deficiency by:

- developing structures that prevent water loss (cuticle, cuticular waxes, trichomes);
- inducing dormancy and leaf shedding (reduces transpiring surface), aiding survival during unfavorable periods (not only in terms of water availability);
- promptly regulating stomatal opening and closure;
- accelerating development;
- wilting, caused by a loss of turgor pressure due to vacuolar water deficiency, leads to leaf reorientation or drooping, thereby reducing sunlight exposure and transpiration.
- utilizing special metabolic pathways to reduce photorespiration;
- synthesizing stress-protective proteins such as LEA (late embryogenesis abundant);
- increasing concentration of osmotically active compounds in the protoplast, e.g. ions and osmolytes (including glycine betaine or the amino acid proline).



COLD STRESS

Low temperatures cause membrane rigidity (reduced fluidity), which plants counteract by desaturating membrane fatty acids. If ice forms, there is a risk of water deficiency stress. Ice crystals may puncture membranes, including the tonoplast. Plants combat ice damage using sugars and specialized antifreeze proteins.

AMINO ACIDS OF PLANT OR ANIMAL ORIGIN?

The source and quality of raw materials are among the key factors significantly affecting both the cost and the agronomic value of final products. This holds true for amino acids as well.

Hydrolyzed proteins exhibit different chemical properties depending on the origin of the raw material and the manufacturing process.

Animal-derived proteins are typically produced via chemical hydrolysis of collagen, using high temperatures and strongly acidic or alkaline conditions.

Chemical hydrolysis relies on the use of concentrated solutions of strong bases (e.g., sodium hydroxide, calcium hydroxide) or acids (e.g., sulfuric acid, hydrochloric acid) under controlled temperature and pressure conditions. These non-selective processes release free amino acids by breaking peptide bonds, but they can also cause degradation (e.g., tryptophan during acid hydrolysis) or transformation (e.g., arginine into citrulline) of other amino acids.

The vast majority (more than 90%) of protein hydrolysates available on the market as biostimulants are produced by chemical hydrolysis from animal proteins, primarily collagen, while enzymatically manufactured protein hydrolysates from plants are a recent innovation and have so far been present only to a limited extent in the market.

Chemical characteristics of hydrolyzed proteins according to protein source and production process

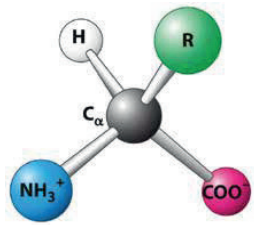
	Protein hydrolysates from collagen (chemical hydrolysis)	Protein hydrolysates from legumes (enzymatic hydrolysis)
Nitrogen content	++	+
C:N ratio	+	++
Degree of racemization	+++	+
Peptides	++	++
Chlorine and sodium Content	++	+

+ = low **++** = medium **+++** = high

TARGETED BIOSTIMULATION AND DIFFERENTIATED, INDEPENDENT STIMULATION OF METABOLIC PATHWAYS

Each amino acid plays a distinct and independent role in plant metabolism. This aspect is crucial, as it enables the use of specific amino acids to stimulate certain metabolic pathways according to the needs of the crop at a given time — allowing for targeted biostimulation.

Especially plant-based protein hydrolysates contain high concentrations of aspartic acid and glutamic acid, which play an important role in nitrogen metabolism in plants.
Proteins hydrolyzed from collagen show glycine (Gly) and proline (Pro) as dominant amino acids.



Animal protein hydrolysates also contain high levels of hydroxyproline and hydroxylysine, which are not directly assimilated by plant tissues.

Animal protein hydrolysates obtained by chemical hydrolysis do not contain tryptophan (it is removed at acidic pH). Tryptophan plays an important role in the physiological processes of plants, as it is a precursor of auxin biosynthesis.

EASY ABSORPTION OF PLANT AMINO ACIDS

The composition of protein hydrolysates also differs in particle size. During enzymatic hydrolysis of plant materials, mainly amino acids with small molecules are formed. When using animal-derived materials, proteins and peptides with larger molecules are obtained.
Larger particles (proteins and peptides) may partially block penetration through the leaf cuticle when applied foliarly. This prevents the absorption of additional substances — both the free amino acids in the product and other compounds contained in nutritional, stimulating, or plant protection products with which the biostimulant is applied.

LEGISLATION AND FOOD SAFETY

In recent times, concerns about the use of animal-based protein hydrolysates in terms of food safety have increased. This is evidenced by the ban on the application of animal protein hydrolysates to edible parts of crops in organic farming (European Regulation No. 354/2014).
Additional restrictions on the use of animal protein hydrolysates may arise in the production of food for vegetarians or for people following religious and/or dietary restrictions against meat consumption, due to the need to avoid any contamination of food with animal-derived products.

RESEARCH FINDINGS

It has been found that some bioactive peptides produced by plants behave similarly to plant hormones (Ito et al., 2006; Kondo et al., 2006).

Phytosulfokine, systemin, SCR/SP11, and CLE are endogenous plant peptides involved in cell differentiation, induction of protease inhibitors, cell division, and pollen self-incompatibility (Ryan et al., 2002).
Matsumiya and Kubo (2011) isolated from degraded soybean meal a peptide that promotes root hair formation on Brassica rapa and tomato cuttings.
Additionally, Ertani et al. (2009) observed that two protein hydrolysates induced gibberellin-like activity and mild auxin-like activity.

WITHOUT THE RISK OF PHYTOTOXICITY AND GROWTH DEPRESSION

In addition to the biostimulant effects of protein hydrolysates, several studies (Ruiz et al., 2000; Cerdán et al., 2009; Lisiecka et al., 2011) report that foliar application of commercial products containing hydrolyzed animal proteins can cause phytotoxicity and plant growth depression.

In contrast, no phytotoxicity or growth depression was observed in tomato plants after foliar application of plant-derived amino acids (Cerdán et al., 2009).
Foliar application of a commercial animal protein hydrolysate on basil leaves caused necrotic spots, while no phytotoxic symptoms or growth depression were observed—even at 10 times the recommended dose—with application of the plant-based protein hydrolysate product «Trainer» (unpublished data).

It appears that growth depression caused by animal protein hydrolysates is related to higher content of free amino acids (especially small ones like glycine and proline) and salts (e.g., NaCl), compared to plant-based protein hydrolysates.

Amino acid	Physiological functions
Alanine	Stimulates resistance to viruses Promotes chlorophyll synthesis Involved in hormone metabolism
Arginine **Methionine**	Precursor of ethylene and polyamines (initiates cell division) Stimulates germination, senescence, and ripening — though may lead to premature ripening
Aspartic acid	Involved in the storage and distribution of amino acids Stimulates seed germination
Glycine	DNA synthesis Alkaloid metabolism Stress metabolism and disease protection Acts as a chelating agent
Glutamic acid	Promotes chlorophyll synthesis Stimulates growth and germination Supplies organic nitrogen for synthesis of other amino acids and proteins Acts as a chelating agent
Iso-Leucine **Leucine** **Lysine** **Histidine**	Involved in alkaloid metabolism Enhances disease resistance Acts as a chelating agent
Proline	Key role in stress metabolism Regulates water balance Supports general plant development Improves pollination
Valine **Serine** **Tyrosine** **Threonine**	Precursor of auxins Stimulates chlorophyll synthesis
Phenylalanine	Precursor of salicylic acid Enhances disease resistance Stimulates germination Precursor of lignin and woody tissues
Tryptophan	Precursor of auxins Stimulates germination

	Quantum AminoMax	Quantum AquaSil	Quantum SeaAmin
Application areas and benefits	reduction of abiotic stress and post-pesticide application stress, enhancing crop resistance to diseases without risk of foliar damage	improved crop tolerance to drought, regulation of the plant's water balance, and reduced risk of canopy overheating. Strengthens cell walls, increasing resistance to both diseases and pests	supports cytokinin synthesis and mitigates stress caused by phosphorus (P) deficiency during crop emergence and spring regeneration of winter crops. Promotes development of a strong root system
Composition	free L-amino acids of plant origin, including a high content of proline, and an optimal ratio of readily available N, P, and K, along with micronutrients in chelated or water-soluble forms	high content of silicon (SiO_2), readily available potassium (K_2O), and humic substances	Ascophyllum nodosum seaweed extract (Acadian SeaPlants), optimal ratio of available N, P, K, and a beneficial level of organic carbon (TOC)
Application via spraying and recommended Tank Mixes	yes, Quantum® foliar fertilizers, fungicides, insecticides	Yes, water conditioning with a sequestering agent	yes, Quantum® foliar fertilizers, fungicides, insecticides
Seed treatment application	yes, e.g., with Quantum® UltraComplex.	no	yes, e.g., with Quantum® UltraComplex.

STRESS REDUCTION CAUSED BY PHOSPHORUS (P) AND POTASSIUM (K) DEFICIENCY THROUGH FOLIAR NUTRITION

Foliar nutrition provides an easy and effective way to maintain the nutrient balance in plants, which is not always the case with root nutrition and nutrient uptake from the soil. The uptake of essential nutrients by plant roots is often limited by the size and distribution of the root system, soil temperature, soil solution pH, soil moisture, nutrient imbalances in the soil, and other factors. The interactions between these factors are well described in Mulder's Chart.

In contrast, macroelements applied via foliar nutrition are mobile within the plant and are easily translocated through plant tissues. After foliar application, potassium is quickly absorbed through the leaf cuticle and is highly mobile within the plant, while phosphorus is absorbed more slowly but also moves rapidly once inside the tissues.

Soil-applied phosphorus (P) and potassium (K) fertilizers usually provide sufficient nutrients for the entire growing season. However, in areas with higher yield potential, supplemental foliar application of P and K during the vegetation period is not only necessary but also profitable (Noack et al., 2010).

High-yield potential zones can be easily identified, for example, using relative yield potential maps, and the base fertilization rates can be adjusted accordingly to meet the specific requirements of these zones.

During the growing season, foliar fertilization with phosphorus (P) and potassium (K) can be efficiently implemented using site-specific or variable-rate application technologies based on application maps. In general, the efficiency of foliar nutrition is several times higher compared to root uptake, as confirmed by scientific literature and agronomic practice.

HIGH MOBILITY OF PHOSPHORUS IN PLANTS

Phosphorus is highly mobile within plants and, in case of deficiency, is translocated from older tissues to newly developing, actively growing plant parts. As a result, plants often show a rapid vegetative response to phosphorus application.

During plant maturation, phosphorus moves into reproductive parts, where energy demands for seed and fruit development are very high. Phosphorus deficiency at the end of the vegetation period affects not only seed development but also the normal ripening process of crops. The phosphorus demand at the end of the growing season exceeds the need for nitrogen or potassium. Therefore, plants respond well to foliar phosphorus application.

The efficiency and benefit of foliar phosphorus application depend on several factors. Foliar application of phosphorus should be performed outside periods of water stress — whether during drought or excessive rainfall (Denelan, 1988). The optimal timing for foliar phosphorus application is during the active growth phase of crops.

Phosphorus deficiency stress may also occur during the transition from the vegetative to the generative growth phase.

Among the highly effective fertilizers for supplying phosphorus (P) during the early stages of intensive growth are Quantum® UltraComplex and Quantum® SeaAmin. These products are suitable for both uniform and site-specific/variable-rate application.

Quantum® UltraComplex effectively supplies phosphorus (P), nitrogen (N), and potassium (K), along with essential micronutrients in an optimal ratio, minimizing antagonism and immobilization in the soil profile.

Quantum® SeaAmin promotes the production of cytokinins and auxins, which are crucial for developing a strong and healthy root system. It reduces the negative effects of phosphorus (P) deficiency and increases plant tolerance to drought and heat stress.

PHOSPHORUS IS ESSENTIAL

Phosphorus is an essential nutrient that forms part of several key compounds in plant structure and also acts as a catalyst in crucial biochemical reactions within plants. Phosphorus is best known for its role in capturing solar energy and converting it into vital plant compounds.

Phosphorus is a critical component of DNA — the genetic «memory unit» of all living organisms. It is also a constituent of RNA, the compound responsible for reading the DNA genetic code and synthesizing proteins and other compounds essential for plant structure, seed yield, and genetic transfer. Both DNA and RNA structures are linked through phosphodiester bonds.

Moreover, phosphorus is a vital part of ATP (adenosine triphosphate) — the «energy currency» of plants. ATP is formed during photosynthesis, contains phosphorus within its structure, and participates in all plant processes, from the initiation of growth to grain formation and full maturity.

Phosphorus Is essential for overall plant health and vitality. Phosphorus plays a crucial role in numerous specific growth factors in plants:

- stimulates root development;
- enhances stem and stalk strength, increasing resistance to lodging;
- improves flower formation and seed production;
- promotes more uniform and earlier crop maturity;
- increases nitrogen fixation capacity in leguminous crops through symbiotic rhizobia;
- enhances crop quality;
- boosts plant resistance to diseases;
- supports plant development throughout the entire life cycle.

For these reasons, phosphorus-containing fertilizers are commonly applied at sowing.

GENERAL PHOSPHORUS (P) DEFICIENCY

Phosphorus (P) is a fundamental nutrient required by plants for normal growth and development. Most agricultural soils suffer from phosphorus deficiency (Bashour et al., 1983). The availability and uptake of phosphorus by plants is particularly limited in calcareous and alkaline soils, where poorly soluble calcium phosphate compounds are formed.

Conventional application of phosphorus fertilizers using standard methods may not result in optimal crop yield and quality on such soils, especially in regions with lower rainfall levels.

The formation of insoluble compounds due to chemical reactions in the soil limits phosphorus availability to plants, leading to very low efficiency of phosphate fertilizers (Barber, 1995). Sahin et al. (2007) emphasized that the effectiveness of phosphate fertilizers in achieving maximum yield depends on both rainfall amounts and its distribution over time. In fact, phosphorus availability affects wheat yield more significantly than rainfall itself. Therefore, foliar phosphorus application is essential to achieve maximum yield potential.

SOIL PHOSPHORUS FIXATION INCREASES STRESS FROM ITS DEFICIENCY

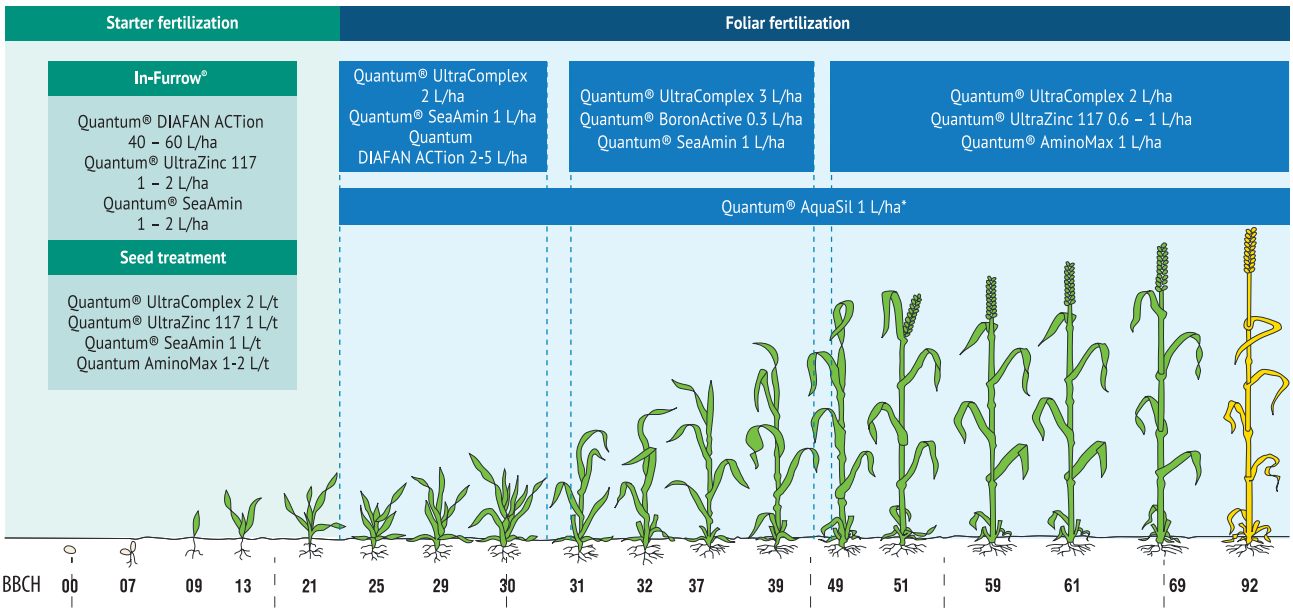
Foliar application of phosphorus is particularly effective when cultivating crops on soils with a high phosphorus-fixation capacity, where phosphorus is bound in insoluble compounds with calcium, aluminum, or iron. In the long term, phosphorus becomes entirely unavailable to plants in such soils.

Even in soils rich in phosphorus, foliar fertilization can be beneficial when soil-bound phosphorus is inaccessible and when the crop is sensitive to phosphorus supply (Silberbush, 2002). This approach not only increases fertilizer use efficiency and reduces production costs but also minimizes the risk of phosphorus leaching — a major contributor to water eutrophication in lakes, reservoirs, and streams (Sharpley et al., 1994).

Throughout the growing season, it is often difficult for plants to acquire phosphorus from the soil because its mobility is limited. Surface application of phosphate fertilizers followed by incorporation into the soil during the growing period would result in crop damage.

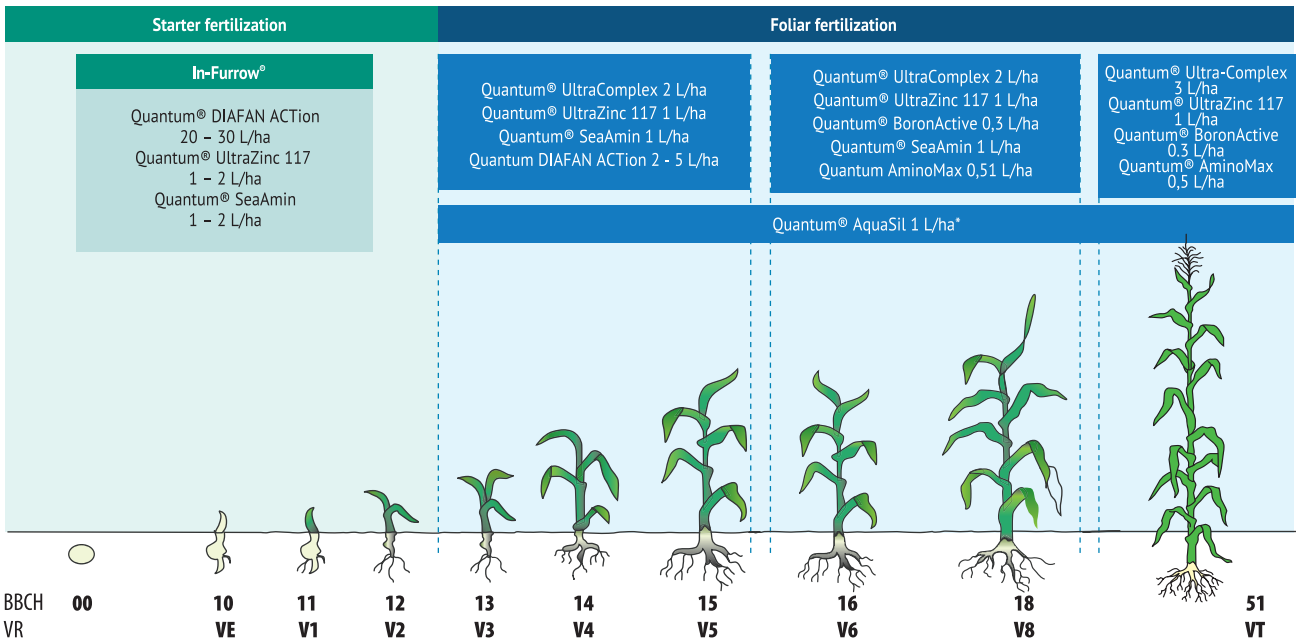
Foliar phosphorus application is therefore an effective and practical method to ensure sufficient phosphorus supply during the season — not only for broadleaf crops but also for vegetables.

CEREALS
(winter and spring wheat, winter and spring barley, winter rye, etc.)



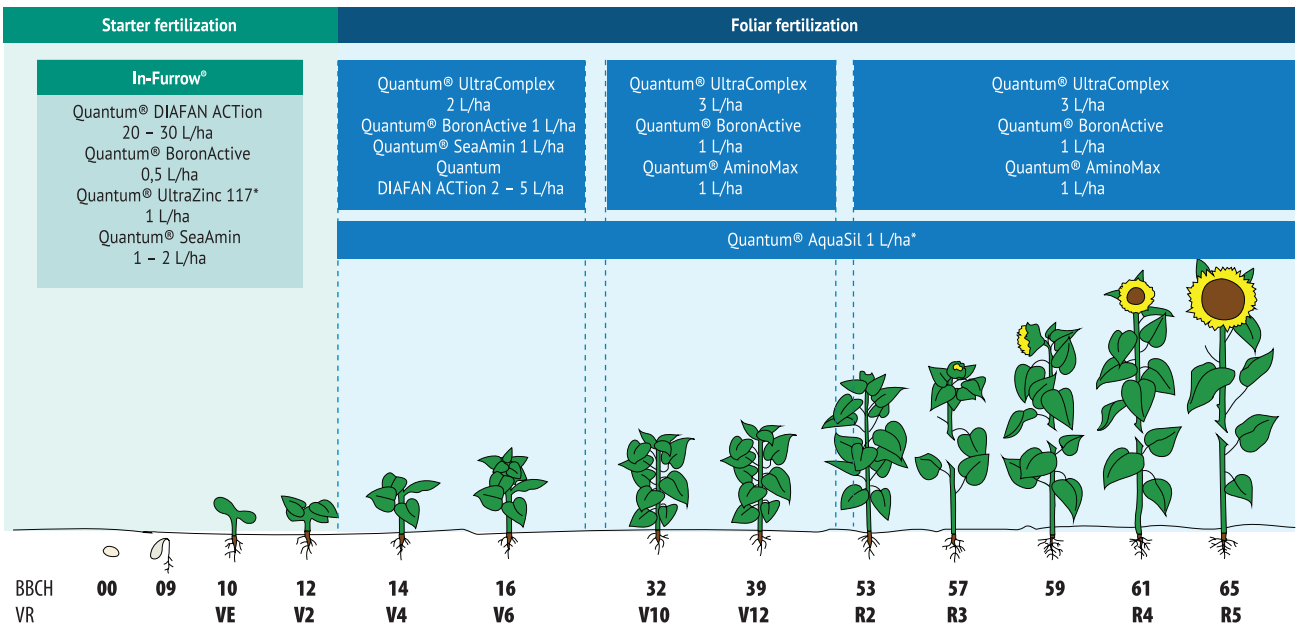
Application value	BBCH 00-09. Seedlings	BBCH 21-30. Tillering	BBCH 31-39. Stem elongation to flag leaf stage	BBCH 83-89. Milk to full ripening stage
	Providing seedlings with P, Zn, and other micronutrients. Stimulating root system growth, increasing germination energy, and ensuring uniform emergence.	Increasing winter and frost resistance, as well as resistance to pathogens. Stimulating tillering, leaf apparatus formation, and root system development.	Providing boron and a complex of macro- and micronutrients. Stimulating the formation of productive shoots and intensifying the photosynthesis process. Enhancing overall stress resistance.	Improving crop quality indicators, stimulating nutrient remobilization, and intensifying photosynthesis.
		To mitigate the negative effects of herbicide treatments or other stress factors, additional treatments with anti-stress products such as Quantum AminoMax 200 (0,5-1,0 L/ha) may be applied if necessary. To increase heat and drought resistance, it is recommended to apply Quantum SeaAmine (0,5-1,0 L/ha). Alternatively, Quantum AquaSil (1,0-2,0 L/ha) can be used in separate tank mixtures.		
		For maximum efficiency of plant protection products and foliar fertilizers, use the organosilicone adjuvant		

CORN



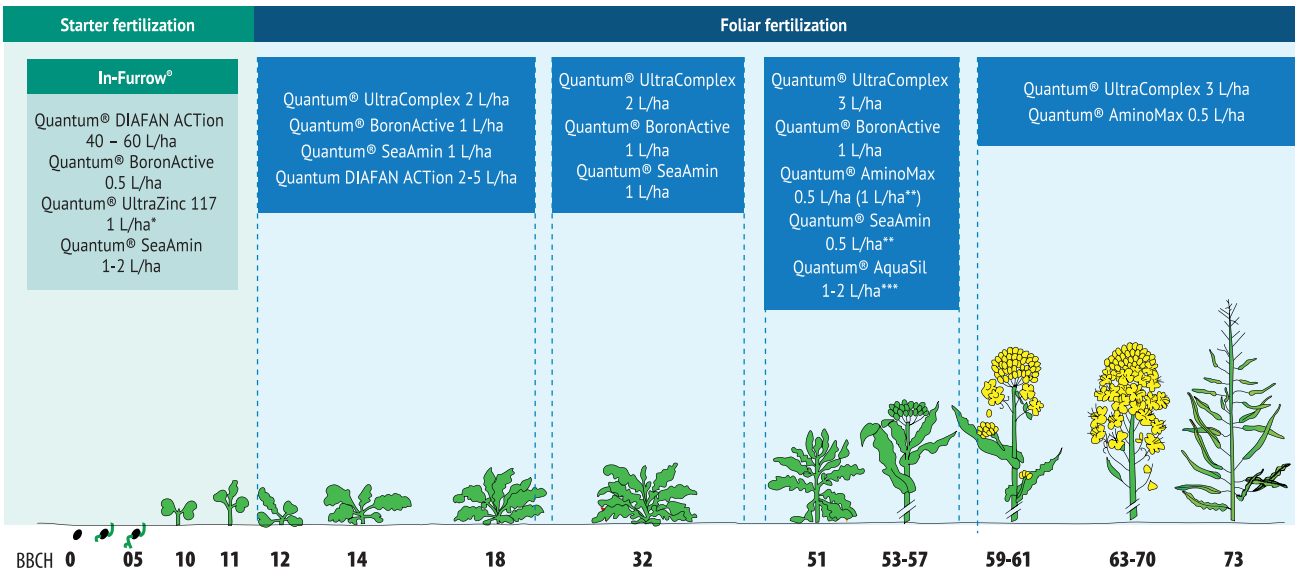
Application value	BBCH 00-09. Seedlings	BBCH 13-15. 3-5 leaves	BBCH 16-19. 6-9 leaves
	Providing seedlings with P, Zn, and other micronutrients. Stimulating root system growth, increasing germination energy, and ensuring uniform emergence.	Promoting the formation of generative organs. Enhancing resistance to pathogen damage. Ensuring zinc availability. Stimulating vegetative mass formation and root system development.	Stimulating the photosynthesis process and increasing overall stress resistance. Enhancing kernel formation in corn ears.
		To mitigate the negative effects of herbicide treatments or other stress factors, separate treatments with anti-stress products such as Quantum AminoMax 200 (0,5-1,0 L/ha) can be applied if needed. To improve heat and drought resistance, it is recommended to use Quantum SeaAmine (0,5-1,0 L/ha). Alternatively, in separate tank mixes, Quantum AquaSil (1,0-2,0 L/ha) can be applied.	
		For maximum efficiency of plant protection products and foliar fertilizers, organosilicone adjuvant should be used at a rate of working solution.	

SUNFLOWER



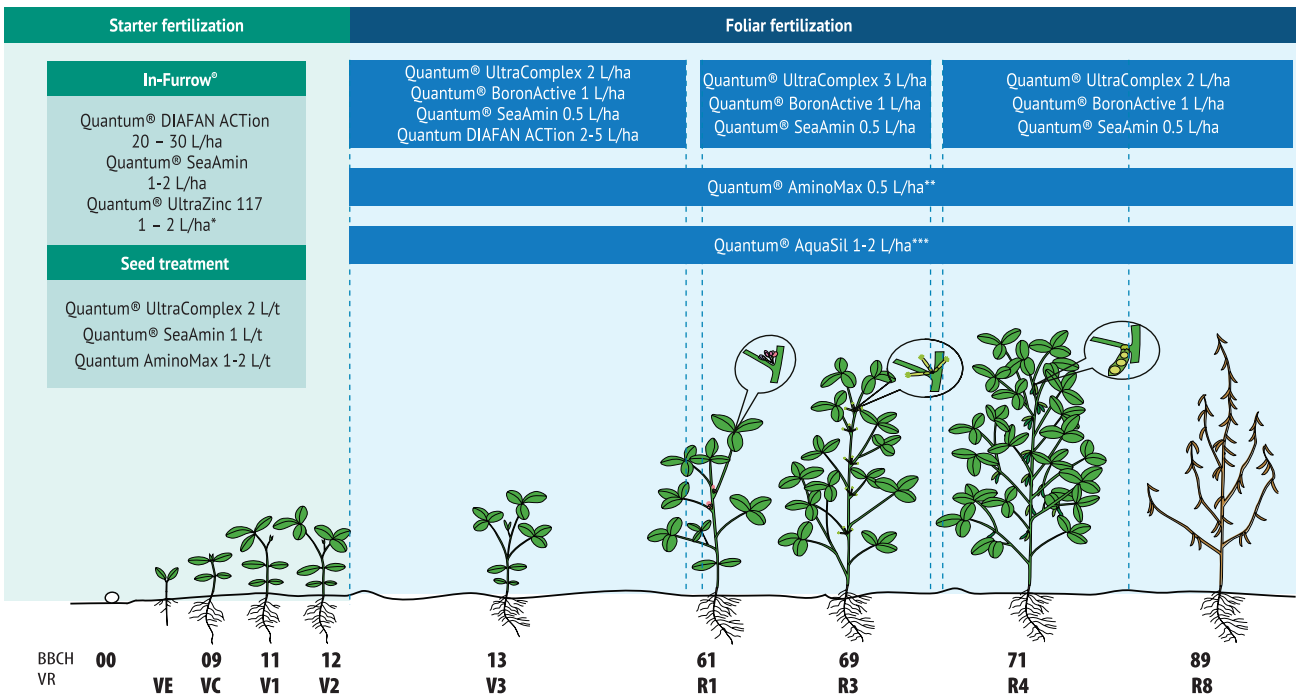
Application value	BBCH 00-09. Seedlings	BBCH 14-16. 2-3 leaf pairs (4-6 leaves)	BBCH 32-39. 5-6 leaf pairs (10-12 leaves)	BBCH 51-57. Bud formation (star phase)
	Providing seedlings with phosphorus and micronutrients. Stimulating root system growth, increasing germination energy, and ensuring uniform emergence.	Ensuring boron and other micronutrients. Increasing overall stress resistance and resistance to pathogens. Stimulating vegetative mass formation and root system development.	Stimulating photosynthesis, enhancing overall stress resistance. Providing boron to support the formation of generative organs.	Stimulating photosynthesis and pollination, ensuring boron and calcium supply, and increasing stress resistance.
		To counteract the negative effects of herbicide treatments or other types of stress, separate treatments with anti-stress products such as Quantum AminoMax 200 (0,5-1,0 L/ha) are recommended when needed. To improve heat and drought resistance, it is recommended to apply Quantum SeaAmine (0,5-1,0 L/ha). Alternatively, in separate tank mixes, Quantum AquaSil (1,0-2,0 L/ha) can be used.		
		To ensure high efficiency of plant protection products and foliar fertilizers, the organosilicone adjuvant of working solution is applied.		

WINTER AND SPRING RAPESEED



Application value	BBCH 00-09. Seedlings	BBCH 14-16 4-6 leaves (for winter– before dormancy period)	BBCH 21-39. Spring rosette – stem elongation	BBCH 50-61. Bud formation	BBCH 71-79. Seed formation
	Provision of seedlings with P, Zn, Cu, Mn, and other elements. Stimulation of root system growth, increased germination energy, and uniform emergence.	Improvement of winter and frost resistance, as well as resistance to pathogens. Enhancement of sugar accumulation in the root collar. Stimulation of root system development.	Supply of boron and a complex of macro- and microelements. Stimulation of productive tiller formation, intensification of photosynthesis processes. Increased overall stress resistance.	Stimulation of flower bud formation and branching, improvement of pollen viability. Enhancement of yield quality indicators, intensification of photosynthesis processes.	Improvement of seed filling and quality indicators of the harvest.
		To mitigate the negative effects of herbicide treatments or other types of stress, if necessary, separate treatments with anti-stress products such as Quantum AminoMax 200 (0,5-1,0 l/ha) should be carried out. To increase heat and drought resistance, it is recommended to use Quantum SeaAmine (0,5-1,0 l/ha). Alternatively, in separate tank mixes, Quantum AquaSil (1,0-2,0 l/ha) can be applied.			
		For maximum efficiency of plant protection products and foliar fertilizers, an organosilicon adjuvant Quantum Gekko should be applied at a rate of 50 ml/100 l of working solution.			

LEGUMES



	BBCH 00-09. Seedlings	BBCH 16-19. 2-5 trifoliate leaves	BBCH 51-61. Bud formation – beginning of flowering	BBCH 71-79. Pod formation
Application value	Provision of seedlings with P and other elements. Stimulation of root system growth, increase in germination energy, and uniform emergence.	Supply of boron, molybdenum, and other micronutrients. Enhancement of overall stress resistance and disease tolerance. Stimulation of leaf apparatus formation and root system development.	Supply of boron and a complex of macro- and micronutrients. Stimulation of flower formation, intensification of photosynthesis. Increase in overall stress resistance.	Intensification of photosynthesis, promotion of well-filled seed formation, improvement of grain filling, and enhancement of crop quality indicators.
		To overcome the negative effects of herbicide treatments or other types of stress, if necessary, separate treatments with anti-stress products Quantum AminoMax 200 (0,5-1,0 l/ha) are carried out. To increase heat and drought resistance, it is recommended to apply Quantum SeaAmine (0,5-1,0 l/ha) or Toggle (1,0-2,0 l/ha). Alternatively, in separate tank mixtures, Quantum AquaSil (1,0-2,0 l/ha) can be used.		
		To ensure the high efficiency of plant protection products and foliar fertilizers, the organosilicone adjuvant of working solution is used.		

Notes

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