

Manufacturer theoretical appeal — scanned English version

Supplied interpretation, not an independent trial. Claims about mechanisms, fertilizer replacement, density or commercial returns require direct measurements and appropriate comparisons. The beet percentage also requires reconciliation with the trial replicates.

Full text and tables in the selected language. Automatic translation with terminology and numerical checks; not a certified translation. Author statements, including disputed claims, are retained. Editorial notes are separate.

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Editorial note

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SIA JIKO ENT

Legal address: Riga, Latvia

Ex. No. 05/06-2026 dated June 5, 2026

To the Professor of the University of Latvia (LU) Doctor of Chemical Sciences, Professor Marisa Klavins

Official appeal

Scientific and theoretical substantiation of nonlinear effects of the ChitoNitia preparation in AREI pot experiments based on nonequilibrium thermodynamics by J. Prigogine

Dear Professor Klyavinysh,

This paper was prepared by the ChitoHumus technology development team (SIA JIKO ENT) in collaboration with scientific co-authors from Riga Technical University (RTU) to provide a fundamental theoretical analysis of the

results of pot experiments conducted at the State Institute of Agricultural Resources and Economics (AREI, Stendes Petniecibas Centrs). The object of the study was leaf lettuce (*Lactuca sativa* 'Lollo Bionda').

We are fully aware that the experimental data points (NPK, NPK+C1, NPK+C2) represent discrete results from isolated laboratory tests. However, considering a living plant organism as a complex dynamic system, we attempted to dynamically extrapolate these data over ontogenetic time. Our goal is to model the continuous process of a nonequilibrium first-order phase transition occurring in plant tissue with a sequential —

increase in the concentration of the chitin-humic complex.

11. Thermodynamic introduction: J. Prigogine's theory in agrobiosystems

A plant organism under conditions of intensive mineral nutrition is a classic open heterogeneous

thermodynamic system, which is in a substantially nonequilibrium state and continuously exchanges matter and energy with the environment. According to the theory of Nobel laureate Ilya Prigogine, the existence and development of such systems is ensured by the formation of spatiotemporal ordered dissipative structures. These structures minimize internal

entropy production ($dS/d\text{min}$) through the constant dissipation of energy supplied from = — outside.

When external control parameters (in our case, the dose of a biologically active complex) take the system far beyond the stable linear regime, the previous stable state (attractor) is destroyed. The system inevitably enters a bifurcation point, characterized by a sharp

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The growth of chaos and internal microfluctuations. According to Prigogine's fundamental principle of "order through fluctuations," the passage of an open system through a stage of temporary metabolic destructuring is a strictly necessary physical condition for overcoming systemic limits and the subsequent

coherent leap to a new, more productive and low-entropy dissipative level.

12. Summary table of parameters and thermodynamic calculations for lettuce (AREI, 2025)

To verify the nature of the phase transition, the table compares standard laboratory AREI measurements with calculated absolute values of dry matter mass, crude protein, as well as calcium and magnesium per plant (based on

experimental ARE! data and elemental analysis):

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Physiological indicator of State II: Lag phase / State II New superorder State I: Stationary Set of Aisries pect Xaoc (NPK + (NPK order (NPK) parameters a ct) C2) Re lant bi 7 siati lata 70.21 65.07 (-7.3%) 77.41 (+10.3%) g Morphology and productivity Leaf length, cm 18.5 18.1 20.5 (+2.0 cm) Number of leaves, pcs. 12 12 13 Dry matter content 5.01 (Max (0M), % 5.45 5.24 ii tori , ti Hydrobalance | yeration! Ch Absolute mass of dry matter ; 3.83 3.41 (-11.0%) 3.88 (+1.3%) per plant, g (calculation) 39.59 (Peak 36.64 (Plateau Crude protein in dry matter, % 37.39 " Concentration) stable) Nitrogen metabolism Absolute mass of protein per plant, g (calculation) 1.430 1.350 (-5.6%) 1.421 0.45 (Critical Calcium (Ca), % 0.52 sais a minimum) 0.60 (Restructuring) Elemental profile (in SV) Magnesium (Mg), % 0.68 0.74 0.79 (Max. absorption) Potassium (K), % 7.70 7.27 7.92 (Inspection pump) Calcium (Ca), 19.90 15.34 (-22.9%) 23.27 (+16.9%) Absolute removal mapa of element Magnesium (Mg), 26.02 25.23 30.64 (+17.7%) mg/plant

| 3. Physicochemical and biophysical explanation of the stages of phase transition

Stage 1. Initial stationary attractor (NPK state) The introduction of complete mineral fertilizer disrupts the system from its primitive equilibrium state of control. The system settles into a stable state with a fresh weight of 70.21 g. At this point, the

genetic and agrochemical potential of the standard background is completely exhausted. Further spatial expansion of the tissue is blocked by the mechanical rigidity of the pectate-calcium matrix of the cell walls and the limited rate of light quanta fixation.

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Stage 2. Induction of plastic chaos and lag phase of restructuring (Dose C1 = 0.1 L/ha)

When the control parameter (C1) is initially applied, the plant organism experiences a structural-metabolic disturbance. The system objectively requires a time interval for genetic and biochemical restructuring, during which the old NPK order is deconstructed:

* Metabolic compression phenomenon: Kinetic inhibition of cell division is observed. Crude biomass temporarily decreases to 65.07 g (-7.3%), and absolute dry matter content drops by -11.0% (from 3.83 g to 3.419).

«Growth dilution (concentration) effect: The crude protein content of dry matter shows a false peak of 39.59%. Mathematical conversion to absolute values proves the absence of a real increase in protein

synthesis: the absolute protein mass per plant drops from 1.430 g to 1.350 g (-5.6%). The slowdown in cell wall expansion outpaces the decline in nitrogen synthesis, causing their spatial “compression” within the

reduced tissue volume. This is a marker of the systemic shock phase and the expression of stress chaperone proteins.

* Biophysical trigger: Cell wall loosening: A key indicator of chaos is a drop in relative calcium to a critical minimum of 0.45%, which corresponds to a drop in absolute Ca removal from 19.90 mg to 15.34 mg (minus 22.9% of the NPK background). Calcium tightly crosslinks the carboxyl groups of polygalacturonic acid in the middle lamellae. Its outflow from the apoplast activates endogenous enzymes (expansins, endoglucanases), triggering the fundamental biophysical process of cell wall loosening. The cellular matrix acquires extreme mechanical instability and structural plasticity.

The system is at a bifurcation point. Linear growth is halted, internal entropy temporarily increases, and free energy is accumulated by cells to overcome the thermodynamic barrier.

Stage 3. Transition to a new dissipative superorder (Dose C2 = 0.2 L/ha)

As the drug concentration increases to the critical level C2, the scale of internal microfluctuations overcomes the barrier. Signaling cascades of chitosan and humates synchronize metabolism, transforming chaos into a coherent growth flow (implementation of a first-order phase transition):

Macroscopic quantum leap: The plant successfully completes the lag phase of restructuring and reaches a super-productive level of 77.41 g of fresh weight (+10.3% of the base NPK and +18.9% of the C1 depression point). Leaves grow 2 cm in leaps and bounds.

Maximization of the "energy pump" (Mg): Absolute magnesium consumption reaches a record 30.64 mg/plant (+17.7% of the NPK background). This indicates highly efficient synthesis and spatial arrangement of chlorophyll porphyrin nuclei. According to Prigogine, the complex dissipative structure must pump an increased flow of free energy (photons) from the external environment to maintain its new, ordered, low-entropy form.

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Calcium Restructuring (Fixing Order): Absolute Calcium Makes a Powerful Difference Areturn jump to 23.27 mg/plant (the concentration in dry matter increases to 0.60%). The cell wall loosening period is complete: Ca²⁺ ions return to the apoplast, cross-link the renewed pectin chains,

and mechanically fix the increased geometric volumes of the cells, establishing a new morphological order.

‘Hydrodynamic coherence: The absolute mass of the protein is stabilized at physiological constant (1.421 g). Activation of the potassium osmotic pump (K peaks at 7.92%) triggers a targeted influx of water, optimizing tissue hydration (DM decreases to the most juicy 5.01%). Protein is coherently and evenly distributed over the increased leaf blade area, ensuring the highest commercial quality of lettuce.

Magnesium and calcium in lettuce: biomass and dry matter.

Table 1						
Treatment	K	C1	C2	NPK	NPK C1	NPK C2
Biomass (green mass), g/plant	1.17	1.35	1.36	70.21	65.07	77.41
Dry matter, g/plant	0.15	0.19	0.18	3.83	3.41	3.88
Blue curve, mg/plant	2.04	2.52	2.30	19.90	15.34	23.27
Orange curve, mg/plant	0.35	—	0.56	26.02	25.23	30.64

Formula shown in the figure: $\text{mg/plant} = (s \times m / 100) \times 1000$. Some legend and unit text in the supplied image is garbled; unlabelled points are left blank.

Fig. 1. Dynamics of biomass, dry matter and removal of macronutrients (Md, Ca) depending on the dosage of ChitoHumus (AREI data, 2025)

14. Scaling the model and scientific and practical prospects

It is important to note that the observed nonlinear dynamics are not an isolated, particular case. Similar emergent nonlinear effects of nonequilibrium phase transitions, which strictly confirm the validity of |. Prigogine's theory, were discovered and verified by us during field and pot experiments on other agricultural crops of various morphological types: potatoes, beets, and peas. The universal nature of the response of complex biosystems to impulses from the chitin-humic complex points to a fundamental physicochemical law governing entropic processes in living tissues.

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Currently, the research team at SIA JIKO ENT, together with specialists from RTU, is developing a mathematical model for identifying instability points in complex biological systems. The algorithm being

developed is designed for precise control of agroecosystems in real time. Calculating precise bifurcation vectors will enable the calculation and application of precisely measured amounts of biomodulator to induce phase transitions according to the "order - controlled chaos - new coherent order" scheme, avoiding the risk of

phytotoxicity and maximizing net bioenergetic yield.

We would be very pleased to hold a joint working meeting to discuss the biophysical aspects of this thermodynamic model and possible vectors of academic collaboration.

With deep respect for your scientific work,

Yuri Vorobiev Andrey Shishkin, PhD

Founder of SIA JIKO ENT, Senior Researcher / Senior Researcher at Riga

Developer of ChitoHumus technology Technical University (RTU)

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