Biological time fluctuation energy of plants in ontogenesis.

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Abstract

The paper considers the issue of biological time fluctuations in the plant ontogenesis. The two-dimensional space of biological time is naturally entered. Change of time is considered as integral of scalar product of two time vectors. The speed of biological time current is defined by the speed of gas exchange CO_2 of the whole plant organism. The fluctuations of rated logistic curve of plant growth and fluctuations of biological time are associated. Changes in kinetic and potential energy of time fluctuations in the ontogenesis for the whole sunflower plant organism are obtained. The plant organism is considered as the simplified system: as conservative system.

Keywords: Time, Energy, Photosynthesis, Respiration, Growth, Development.

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Introduction

We cannot see the time even under the most high-capacity microscope. We may only study the events and processes and compare them with time intervals. In this paper we will study the time in relation to plant photosynthesis and respiration processes, in relation to growth processes, and in relation to the size of the total dry biomass of plant.

It is known that duration of plant ontogenesis is not theconstant value in relation to physical time axis. For instance, the sunflower ontogenesis duration in the south of Ukraine fluctuates from 80 to 120 days of ontogenesis. That is, biological time is stretchable and contractible depending on condition of the environmental factors [1].

The mathematical apparatus is stated in papers. The basic provisions of the theory of fluctuations should be briefly reminded. As a preliminary, we will consider the elementary fluctuation system described by the equation.

Background material of research

Let's consider method of effective temperature sums. The hypothesis of effective temperature sum constancy necessary for passing of one or another phase period is the cornerstone of this method [2]. The moment of occurrence of plant development phase is calculated by two equations. At first, the effective temperature of the current days of calculation is determined.

Thus, the time is measured in this method in Celsius degrees. For transition to real time we should perform the following operation: by the time of set of the effective temperature sum tos equal to A, it is considered that the development phase occurred [3]. Let's divide the right and left members of equation by value A.

It means that we normalized the effective temperature sum. Now this sum is expressed by analogue varying from 0 to 1 of real time. Effective temperature of the current days of calculation will also be expressed in relative units. This value corresponds to one day of physical time. Thus, we passed from the effective temperature sum to relative time where time changes for the whole ontogenesis. The relative time also depends on the average temperature of the current days of calculation.

Let's consider the elementary increment of biological time for one day in the method of effective temperature sum. Such increment depends on air temperature.

So, if air temperature is optimum, then the increment of time will be the greatest, maximum. If air temperature falls to biological minimum, then the increment of time will be zero.

In other words, we can assume that the time vector deviates from its normal position: from physical axis of time.

Such physical axis of time has the direction from the past to the future [4]. Then the projection of this vector to normal physical axis of time will produce real increment of time, (Figure 1).

Value represents the maximum increment of time vector at optimum air temperature. If the temperature falls, the vector deviates. Indeed, at temperature of biological zero, at temperature B, the vector will become orthogonal to time axis, and the increment will be zero: Thus, the deviation angle α depends on air temperature.

This data indicate that the method of the effective temperature sum calculates the amount of projections of the deviating time vector to physical axis of time.

That is, according to this method we calculate the sum of scalar products by physical axis of time. Passing to limit when increment value tends to zero, we obtain the integral of scalar product. At the same time, the line turns into curve in some two-dimensional time space.

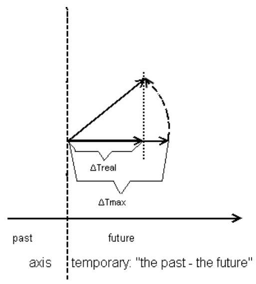

Figure 1. *Deviation of the maximum vector in method of the effective temperature sum if air temperature falls from optimum temperature*.

The plant age is defined by growth and development of the whole organism. In other words, the plant age is defined by the value of the total dry biomass which includes development of its separate bodies and systems. Then, if, for example, the value of normalized total dry biomass of the whole plant is μ (t)=0.3, then the ontogenesis time is 0.3 relative units of physical time [5]. In this case, we will assume that biological time precisely corresponds to value of normalized total dry biomass of the plant μ (t).

Where CV–integration constant, constant of potential energy. We will find constant of potential energy CV such that potential energy V (t) is always positive and equal to zero at minimum point. Then the integration constant is equal to CV=5/4. Now we can construct the graphs of kinetic and potential energy changes during ontogenesis in relative units, (Figure 2).

One can see from the Figure 2, that the kinetic energy at the beginning and at the end of growth takes zero values. In the middle of plant organism growth, at point of ontogenesis half t=0.5 the biological time kinetic energy takes the maximum value K (t) =max value. Potential energy V (t) at the beginning of growth and at the end of growth has the maximum value. Potential energy of biological time fluctuations at the end of ontogenesis, at the moment of plant full ripeness completely passes into seeds, into reproductive organs [6].

According to the law of energy conservation, the total energy of biological time fluctuations is always constant: h=K(t)+V (t)=const. Let's construct change of kinetic and potential energy of biological time fluctuations for real ontogenesis of plants. For this purpose we take sunflower which has been grown in Odessa region, Chernomorka urban settlement in 1986.

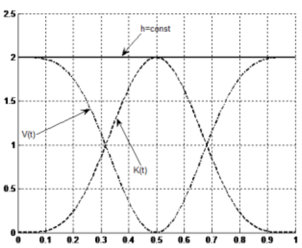

Figure 2. *Change of kinetic K (t), potential V (t) and total energy h=const of plant biological time fluctuations in ontogenesis, relative units.*

Example of potential and kinetic energy calculation in actual environmental conditions*.*

For such calculation we will adhere to the following scheme. At first we will calculate the level of tension of environmental factors for every day of ontogenesis. Then we will calculate change of relative time t in relation to calendar time. Then we will calculate real dynamics of the total sunflower dry biomass during ontogenesis [7]. We will need the final value of the total plant dry biomass. Then we will make normalization and calculate the kinetic and potential energy of sunflower in actual practice of ontogenesis in 1986 [8].

Let's calculate tension of environmental factors. At the same time, we will assume that the soil nutrition level is at quite high (optimum) level and does not affect the processes of current of biological time. For integration we have to choose the integration step value (Figures 3 and 4) [9].

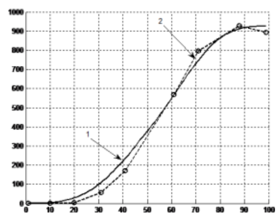

Figure 3. *Dynamics of growth of the total dry biomass of the whole sunflower plant in ontogenesis of 1986: 1–design values; 2-values received by the author as a result of experimental observations in Chernomorka urban settlement in1986*.

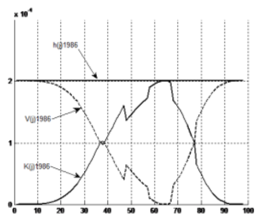

Figure 4. *Kinetic K(j)1986, potential V (j)1986 and total h(j) 1986 energy in ontogenesis of the sunflower grown in 1986 in Chernomorka urban settlement.*

According to our data on sunflower growth in 1986, the blossoming of sunflower was on 63rd day from sprouts that corresponds to maximum value of kinetic energy in ontogenesis. The same event of sunflower “blossoming” corresponds to minimum value of the potential energy [10,11].

Conclusion

We started this research with the analysis of the method of effective temperature sums. Also we came to conclusion that the speed of plant development depends on photosynthesis and respiration of the crop: on gas exchange CO_2 of the whole organism of plant. At the same time, it is possible to consider the abstract intervals of time. If we assume that time in plant organism stretches and contracts depending on condition of environmental factors linearly, then we will derive the same conclusions on the basis of the fact that the time vector turns around the point of current moment of ontogenesis. And we calculate the scalar product integral.

It is known that the development speed is defined by factors of temperature, moisture, light, and plant nutrition. In our case, we found that the speed of current of biological time is entirely defined by the total gas exchange CO_2 of crop, which in its turn is defined by factors of light, temperature, moisture, nutrition and other factors. For example, change of CO_2 contents in the air. Development speed will also depend on this factor.

Also we should note that this equation of harmonic fluctuations is defined for the complete organism of plant. At the same time, the plant consists of the growing bodies: leaves, stems, roots, and reproductive organs. Growth of these bodies is also described by received logistic curve in normalized. Then the biological time of body will also be described by the equation of harmonic fluctuations of the time, up to cells. The researches of the isotope observation of cell metabolism demonstrate that the carbon metabolism in photosynthesizing cell is fluctuating process. But this is the material of other research.

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