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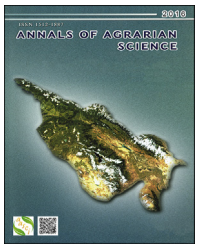

Climate changes and photosynthesis

G.Sh Tkemaladze*, K.A. Makhashvili

Georgian Technical University, 77, Kostava Str., Tbilisi, 0175, Georgia

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ABSTRACT

This paper is a review. According to the latest data issued by the UN, global warming causes danger to human health and well-being, as well as to animals and plants. As global warming is mainly caused by anthropogenic activities, it was considered that emission of the so-called greenhouse gases should be reduced and in some cases even prohibited. Plants are more easily exposed to biological damage than any other living organisms. The paper deals with the biochemical measures that will increase plants' biological potential, in particular, their photosynthetic and energy opportunities and, therefore, will contribute to drought resistance and will prevent increase of carbon dioxide concentrations in the atmosphere.

Solar energy is environmentally friendly and its conversion to energy of chemical substances is carried out only by photosynthesis – effective mechanism characteristic of plants. However, microorganism photosynthesis occurs more frequently than higher plant photosynthesis. More than half of photosynthesis taking place on the earth surface occurs in single-celled organisms, especially algae, in particular, diatomic organisms.

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Today, the growing threat of global warming is becoming more and more vivid. The world of plant which is also seriously affected has to play the significant role in the process of surviving humans and the whole ecosystem [1–3]. According to the latest data issued by the UN in 2013–2014, it is confirmed with 95% probability that the global warming is caused by anthropogenic activities and is conditioned by the so-called Greenhouse effect [4].

The table below presents the percentage distribution of the existing gases in the Earth's atmosphere [5–7]. The data corresponds to the sea level (1 atm pressure). The molecular weight of dry air is 28.966.

Table 2 lists the major greenhouse gases, their emission levels and sources, and the approximate amount of time they remain in the atmosphere once they are emitted. It also gives their approximate concentrations 100 years ago, today and projected concentration for the year 2030 [5–7].

Greenhouse effect is called the obstacle that occurs when greenhouse gases emitted in the atmosphere transmit thermal energy from the Earth's surface to the space. In other words, the greenhouse gases which easily transfer the solar energy to the earth, traps longwave thermal energy in the space due to high absorption capacity of infrared rays. This causes planetary (global) warming of the atmosphere and, consequently, oceans, seas and terrestrial planet [8].

Modern atmosphere mainly consists of nitrogen, oxygen and argon (see Table 1). It easily transmits solar light. Earth's surface reflects and absorbs mainly infrared radiation. The flow of infrared radiation of the earth depends on the optical features of the atmosphere. Thus, the atmosphere's reflection

* Corresponding author. Tel.: +995 599 941 541.
E-mail address: g.tkemaladze@agruni.edu.ge (G.Sh Tkemaladze).
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and absorption ability is determined by the gases exiting in the atmosphere in small portions (carbon dioxide, methane, nitrogen monoxide and aerosols – Freons).

It is estimated that since 1970s, over 90% of the sun energy is absorbed by oceans. The rest heats the earth (9%) and the atmosphere (1%). It has been estimated that 140 trillion tons of carbon dioxide are dissolved in ocean waters what 60 times exceeds the amount of carbon dioxide in the atmosphere. The average temperature of ocean waters is 3.5 °C and that of the land −15 °C. Ocean warming will increase the amount of carbon dioxide in the atmosphere due to reduction of carbon dioxide solubility in the oceans. Generally, it is known that the world ocean is the main accumulator of heat and gases; it accumulates 1000 times more heat than in the atmosphere. So it is considered that significant climate changes in such a complex system can only occur in centuries and millenniums [9].

Nowadays, the main goal is to maximally reduce air pollution caused by greenhouse gases, particularly, by carbon dioxide. In this regard, biological conversion of solar energy by plants is of utmost importance what leads to reducing the amount of carbon dioxide in the atmosphere. As a result, the percentage of the amount of oxygen increases [10].

However, there is an opinion that the greenhouse effect is a natural atmospheric phenomenon. If this phenomenon was completely excluded, our planet's average temperature would be about −21 °C, instead of the current + 14 °C [9]. The same source cites these data: technogenic emission of carbon dioxide in the atmosphere is about 1.8 billion tons per year; plants absorb 43 billion tons of carbon dioxide. However, due to plant respiration, fires and degradation processes, the most part of the absorbed carbon dioxide will again appear in the atmosphere. Only 45 million tons will appear in deposited plant tissues, in the wetlands and oceans depths. Hence, the conclusion is that people have the potential power to positively affect climate change. Moreover, in the process of global warming, particularly in the greenhouse effect, carbon dioxide and water vapor exceed 95%.

For comparison – on the closest planet, Venus the temperature is 500 °C and carbon dioxide comprises 98% of its atmosphere.

At present, humanity annually burns 4.5 billion tons of coal, 3.2 billion tons of oil, oil products and natural gases. All these fuels cause the growth of carbon dioxide in the atmosphere, which from the 50s–90s of the last century rose from 0.031% up to 0.035%. At the same time and the amount of methane increased dramatically [11].

The UN estimates that this century the average temperature will increase from 1.4 up to 5.8 °C. The sea level can rise to several dozens of centimeters what will greatly endanger population of islands and coastal states. Amount of rainfall will be reduced what will result in turning the most part of the terrain into desert; at the same time the number of flood and hurricanes will increase.

A few years later, humanity will appear in unusual and dangerous world where, due to uncontrollable infectious diseases, new lethal epidemics will increase. Warm and humid climate that will be on the planet in 20 years time will further strengthen the relevance of this forecast. Today, [11]:

1. The Arctic ice cover has been decreased by 10–15%.
2. Starting from the midst of the 1950s to 1970, on the Antarctic coast ice retreated 2.8° longitude to the south.
3 Rise of average temperature by one degree caused spreading of Alaska's forests to the north over 1000 km.
4. The ice cover of lakes and rivers on the middle and upper longitudes of the Northern Hemisphere starts melting 2 weeks earlier than in 1850.
5. In Europe, some mountainous plants migrate to upper locations at the speed of 1–4 m per 10 years.

Table 1 – Chemical composition of the atmosphere.

Gas	Chemical symbol	Molecular mass	Percentage by volume	Percentage by weight	Partial pressure, mmHg	Melting point, °C
Nitrogen	N_2	28.016	78.09	75.5	593.4	−195.79
Oxygen	O_2	32.00	20.95	23.15	159.2	−182.95
Argon	Ar	39.944	0.93	1292	7.07	−186
Carbon dioxide	CO_2	44.010	0.0355	0.046	0.23	−78.5
Neon	Ne	20.183	0.0018	0.0014	0.014	−246
Methane	CH_4	16.00	0.0002	0.000084	–	–
Helium	He	4.003	0.000524	0.000073	0.0038	−269
Krypton	Kr	83.80	0.000114	0.0003	0.00084	−153.4
Hydrogen	H_2	2.016	0.00005	0.00008	0.00038	−252.87
Nitrous oxide	N_2O	44.016	0.00005	0.00008	–	–
Xenon	X_e	131.3	0.0000086	0.00004	0.000061	−108.1
Ozone	O_3	48.00	0.000002	0.0000033	–	–

In different parts of the Earth, air composition for each gas may vary within 1–3% (by volume). Air always contains water steam (0–4%). For example, on 0 °C, 1 m^3 air contains ≈5 g of water, + on 10 °C, – ≈10 g of water. Air contains hydrogen peroxide (≈1%), ammonia (≈2.10–6%), sulfur dioxide – 0.0010%, nitrogen dioxide – 0.000002%, iodine – 0.000001%, trace of carbon monoxide and various radioactive emanations (radiation), a total of ≈6 × 10–18%. On the top of the stratosphere, alongside with the increase of altitude, there is a slight reduction in number of relatively heavy gases. For example, at18 km above the Earth's surface, the oxygen concentration is not changed, but at 28–30 km its concentration is 20.39%. The percentage of air composition is not changed at 10 thousand meters above the Earth's surface. The average air temperature is reduced to 0.6 °C per 100 m. Carbon dioxide composition in the air depends on the length of day and night, i.e. on the daily cycle: it is more at night and is significantly reduced during the daytime (due to photosynthesis). The amount of ozone varies according to the seasons and reaches the maximum in the spring.

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