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ANNIVERSARY

LIFE AND SCIENTIFIC ACHIEVEMENTS OF PROF. Dr. Sci. IVAN YORDANOV

IN HONOR OF HIS 70TH BIRTHDAY ANNIVERSARY

Ivan Stoyanov

Prof. Ivan Todorov Yordanov was born in the village Asparouhovo, Varna district, in 1928. He finished his secondary education at the Provadia Gymnasium. In 1954 he graduated from the Leningrad State University and was appointed assistant at the Biology-Geology-Geography Faculty of the University in Sofia. He received a Ph.D. from the Moscow Timiryazev Academy of Agriculture. In 1960 Ivan Yordanov was appointed research associate at the Academic Metodi Popov Institute of Plant Physiology in Sofia. In 1963 he specialized for 6 months at the laboratory of the world-famous Prof. Mothes in Hale, Germany. In the course of 7 years (1967–1974) he worked as a scientific secretary of the Institute of Plant Physiology. In 1974 he was elected associated professor. In 1970, after the death of Prof. K. Popov, Ivan Yordanov became the chief of a problem group at the Institute and the main coordinator of the theme “Investigations on the biogenesis, structure and function of the photosynthetic apparatus in relation to sun energy transformation” of the CMEA problem 1.18.2. In 1984 Ivan Yordanov was given his Dr. Sci. degree and in 1987 was elected professor at the Faculty of Biology of the St. Kliment Ohridski University in Sofia. Since 1970 until he retired Prof. Yordanov had been the head of the Department of Photosynthesis at the Institute of Plant Physiology in Sofia. In the course of many years he has been cultivating personal contacts with researchers from many laboratories abroad, especially in Germany and the USSR, as well as with the Institutes of the Agricultural Academy and the Academy of Sciences in Sofia. His several short or long lasting specializations in the USSR, DDR, BRD, etc. have also contributed to his high scientific erudition. He has taken part in numerous symposia, congresses, scientific-coordinating conferences etc., where he has presented more than 25 lectures.

Prof. Ivan Yordanov has been successfully combining intensive research work with pedagogical activity. Since 1961 till 1997 he delivered a course of lectures on photosynthesis to students in biology. Besides, he delivered the main course in plant physiology at the Paisii Hilendarski University in Plovdiv in the course of 3 years and at the Higher Forestry University in Sofia for one year.

It is difficult to enumerate all fundamental and applied scientific achievements of Prof. Ivan Yordanov. He has focused his attention mainly to the investigation of different aspects of photosynthesis. He has published more than 170 papers in Bulgarian and foreign research journals. He is the main author and editor of the monograph "Formation and functional activity of the photosynthetic apparatus" (1984) published in Bulgaria and many of his articles have been published in well known international periodicals such as "Plant Physiology", "Journal of Plant Physiology", "Physiologia Plantarum", "Plant Science", "Environmental Pollution", "Physiologia Rastenii" (Moscow) etc. His articles have been cited more than 300 times in Bulgaria and abroad. I shall point out only some of the more important achievements of Prof. Yordanov and his co-authors.

In the field of plant growth and development

Even as a student he established certain regularities in the process of vernalization in winter cereal plants. He proved that this process proceeded faster when young green wheat plants but not imbibed seeds, were treated with low temperature. He showed later that even at constant conditions the rate of photosynthesis changed during the day as well as in ontogenesis and the maximal photosynthetic rate not always correlated with the maximal growth rate. In addition, each leaf had its own daily rate of photosynthesis.

Together with Dr. Parthier he showed that protein biosynthesis in the leaves of Bryophyllum and Kalanchoe reached its maximum in the evening whereas in the morning the minimal values were registered. He investigated also the effect of various physiologically active compounds on growth and photosynthesis of many plants proving that xanthogenates, itaconic acid esters, kinetin, CCC, GA, IAA, ATUSK and Mg^{2+} defficiency caused significant changes in photosynthetic rate and in the distribution of photoassimilated ^{14}C in various groups of compounds.

Prof. Yordanov created a model system for comparison of equal in age, but differing in physiological state bean plants by means of decapitation of the tested plants. This model system was successfully used in the study of the effects of various stress factors (treatment with antibiotics, low and high temperature, heavy metals, UV irradiation, etc.) on the structure and functional activity of photosynthetic apparatus (PSA). It was shown, for example, that the inhibitory effect of tetracycline on photosynthetic rate and plastid pigments was higher than that of chloramphenicol in all groups of plants tested (decapitated and non-decapitated). Moreover, it could mask to a greater extent the effect of plants initial physiological status. It was also shown that the structure and functional characteristics of the primary leaves of decapitated plants were closer to those of younger leaves rather than to their respective in age leaves of non-decapitated (control) plants.

In the field of photosynthesis

The Ph. D. Thesis (1960) of Prof. Yordanov comprises considerable information on the changes in the daily rhythm and intensity of photosynthesis during ontogenesis of spring wheat plants. Later he established higher thermal resistance of the photosynthetic apparatus assessed by cyclic phosphorilation, electrochromic shifts of pigment absorption at 518 nm, variable fluorescence etc, in physiologically younger primary leaves of decapitated plants compared to the non-decapitated (control) bean plants of the same age.

In relation to the characterization of the photosynthetic apparatus Prof. Yordanov elaborated a method for enhancing the heat tolerance of young plants by their stepwise hardening. The subsequent treatment of plants with gradually increasing and normal temperatures as it occurs under natural conditions, can increase their adaptation ability. This process of temperature treatment induced the biosynthesis and accumulation of a specific heat shock protein (HSP21) in chloroplasts, which being associated with thylakoid membranes was an important factor for their stabilization. In addition, HSP21 was proved to be of great significance for the maintenance of the normal supramolecular organization and functioning of some of Calvin cycle enzymes under high temperature stress. The acclimation of plants to heat stress enhanced the thermoresistance of photoinduced transmembrane proton gradient. Under similar stress conditions non-acclimated plants were considerably injured.

It was also shown that high temperature stress caused dramatic quantitative and qualitative changes in phenyl amides. Based on the fact that the latter function as scavengers of toxic free radicals it was suggested that they could be components of plant defense system under stress conditions. On the other hand, the addition of stabilizing substances (sucrose or serum albumin) to isolated chloroplasts enhanced greatly the thermal resistance of thylakoid membranes, as well as of transmembrane proton gradient, variable fluorescence, delayed fluorescence etc. In the presence of sucrose whose stabilizing effect was more pronounced in the acclimated plants, the energyzation of the membrane was inactivated at the same temperature, at which the oxygen-releasing system was inactivated.

The experimental data showing that the thermal tolerance of chloroplasts was a consequence of both the incorporation of the newly synthesized specific HSP 21 in the thylakoid membranes and the enhanced synthesis of some digalactosyl diacylglycerol molecular species, represent a significant step in understanding plant heat tolerance. The increased content of digalactosyl diacylglycerols as compared to monogalactosyl diacylglycerols resulted in thermotolerant conformations of the photosystems as well as a decrease in lipid matrix fluidity.

The comparative study of photosynthetic rate and ^{14}C-distribution in photoassimilates in plants belonging to various systematic groups, grown under green-house conditions, revealed a wide range of variation in their photosynthetic activity. On the other hand, the distribution of ^{14}C in the different fractions appeared to be quite similar in a number of species regardless of their phylogenetic characteristics.

A substantial ability for reparation of the photosynthetic apparatus functional activity was found in our relict endemit *Haberlea rhodopensis.* This process of reparation was accompanied by a restoration of turgor as well as of the interaction between plastid and cytoplasmic metabolism.

It was also reported that light conditions at which leaves are formed determine to a greater extent the physiological activity of their photosynthetic apparatus. The lower light intensity during the formation of leaves accounts for the reduced photosynthetic rate at equal illumination.

A considerable share of the investigations of Prof. Yordanov and his collaborators concern the effect of different stress factors, including pollution of environment, on the state and functional activity of the photosynthetic apparatus.

It was found that in sunflower plants which had endured combined stress (high temperature and water deficit), the variable/initial fluorescence ratio (F_v/F_o) measured at 47°C, characterizing the state of electron-transport chain and the photosynthetic apparatus functional activity at light saturation, increased considerably, whereas in maize plants this ratio remained almost unchanged. Besides, the ratio between the F_o values measured at 25 and 47°C, F_o (25°C)/F_o (47°C), characterizing the light-harvesting complex stability at high temperature, was higher in sunflower than in maize plants. Consequently, the higher values for this ratio reflect the higher thermotolerance ability of the light-harvesting complex. Furthermore, the combined treatment of plants with high temperature and enhanced water deficit resulted in an almost complete inhibition of both photosynthetic CO_2-uptake and oxygen evolution. It was also found that the negative effect of water deficit and particularly of combined stress can be reduced by treatment of plants with the carbamide cytokinin 4-PU-30. Pretreatment enhanced heat tolerance, whereas post treatment facilitated reparation processes in the photosynthetic apparatus.

Using the methods of chlorophyll fluorescence and circular dichroism spectra measurements the heat- and light-induced reversible and irreversible changes occurring in the macroorganization and functional activity of the photosynthetic apparatus were investigated. In collaboration with Hungarian colleagues Prof. Yordanov and coworkers established that the thermal stability of macrodomains was considerably lower than that of the constituting pigment-protein complexes. A comparison of the sensitivities revealed that samples exhibiting weaker thermal stability also possessed weaker light stability. The light sensitivity of macrodomains also depended strongly on the temperature. These data are consistent with the hypothesis that light-induced structural rearrangements are due to thermal fluctuations resulting from the dissipation of the excess exciting energy.

The extensive investigations of Prof. Yordanov and his collaborators on the effects of environmental pollution on the photosynthetic apparatus are also of considerable interest. It was found that lead ions taken up by the roots strongly inhibited growth. Besides, they caused considerable changes in ^{14}C-distribution between the various groups of compounds. However, their effect on the photosynthetic rate and chloroplast photochemical activity was insignificant. Pigment content per unit leaf area was considerably higher compared to control plants. This result could be explained mainly by an increased pigments concentration due to the inhibited leaf growth rather than by enhanced *de novo* synthesis.

Treatment of barley plants with cadmium inhibited the formation of photosynthetic apparatus and its CO_2 -assimilation capacity. It also decreased the content of leaf total soluble proteins, enhanced the rate of dark respiration and caused water regime disbalance.

A single treatment of bean plants with simulated acid rain (pH around 2) decreased considerably photosynthetic gas exchange, maximal carboxylating efficiency and photochemical fluorescence quenching. On the other hand, these changes were accompanied by increased CO_2 compensation point and non-photochemical quenching. It was also found that pretreatment of plants with the polyamines spermidine and spermine could protect to a considerable extent their photosynthetic apparatus from the destructive effect of simulated acid rain. The protective function of both polyamines is related to their antioxidative properties together with their ability to stabilize the biological membranes by binding with negatively charged phospholipids.

In the course of many years Prof. Yordanov actively participated in the work of the group of scientists from the Institute engaged in the project for creating a space greenhouse “Light”, in relation to space experiments for studying the water-air properties of the substratum “Balkanin” as well as the conditions for cultivation of vegetable plants at the space station “Peace”. He took also an active part in elaborating a suitable regime for storage of glasshouse cucumbers during their transport to far off locations.

Due to his fundamental achievements, scientific and applied contributions, his high scientific erudition, his sympathy and readiness to help young researches and scientists, Prof. Yordanov has a high reputation in Bulgaria and abroad as a leading specialist in plant physiology and biochemistry.