Mausam, (1992), **43**, 4, 455-456

Review

Impact of Global Climatic Changes on Photosynthesis and Plant Productivity

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Published by Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 824 pp., 1991, 25×16.0 cm

The book under review is the Proceedings of the Indo-US Workshop held on 8-12 January 1991 at New Delhi, India. Dr. A.P. Mitra, former DG, CSIR, New Delhi in his opening lecture gave and overview of the activities being undertaken by Indian Scientists and the facilities available in the country to study global climatic changes.

The first section of the book, encompassing twelve papers, deals with the effects of UV-B radiation. Prof. Coohill has explained the use of action spectroscopy in assessing the effect of UV-B on living organisms. In the first half of next paper, the author has discussed the importance of providing realistic irradiation to investigations of plant response to UV-B, both in terms of energy and spectral distribution. In the latter half, different techniques for measuring UV-B radiation have been discussed. Drs. Renger and Eekert have analysed the deleterious effects of UV-B and visible light on photosynthetic water cleavage in PSII membrane fragments from spinach. In the next paper, workers from Madurai Kamraj University, based on their interaction studies between herbicide (DCMU) and UV-B radiation could conclude that both these have the same site of action in PSII, thus indicating that UV-B in wheat affects both the O_2 evolving complex and the PSII core, which is different from those reported for *Amaranthus* and *Vigna sinensis*. The results of the lab and field experiments conducted with a number of crops reported in the paper of Giller from USSR, have established a taxonomic link of UV-B effect. Further, visible light integrity has been shown to have a powerful effect on plants resistance to UV-B by Goyal and Tolbert. The authors from BHU, India have shown UV-B radiation to inhibit photosynthesis and N_2 fixation in *Nostoc muscorum*. The combined effect of UV-B with Cd^{2+} has been reported in the next paper. In the next two papers, the authors have cautioned against extrapolation of the results of growth chamber studies to field conditions. It has also been emphasized that to have realistic assessments of UV-B effects, studies need to be conducted on interactions of UV-B radiation and other environmental stress factors. A comparison between the growth response of C_3 crop wheat and C_4 crop maize to enhanced UV-B radiation has been made. The last paper in this section deals with the growth response of mungbean to enhanced UV-B.

Section II on CO_2 enrichment/balance, comprising of eight papers, deals with the physiological and biochemical effects of CO_2 enrichment on crop plants. In most of these papers, the general response of elevated CO_2, level in the environment include: increased photosynthesis, changed growth rate, decreased transpiration, decreased stomatal conductance, increased tolerance to atmospheric pollutants, increased leaf area, increased leaf dry weight/leaf area etc. However, results reported in most of the papers are again obtained from experiments conducted in green house. Accordingly, long term studies during all stages of the life cycle of plants are of plants are needed to answer questions on effects of long-term global atmospheric CO_2 enrichment on vegetation. Furthermore, experiments are needed to understand interactions between CO_2 and other environmental factors. Bailey and his associates in opening paper of this section have reported this experiments to measure CO_2 response in tree seedlings grown from seed. Dr. Peet and his colleagues have presented case studies on chrysanthemums, cucumbers and tomatoes, which have revealed difficulties in generalizing plant response to elevated CO_2 concentrations. Dr. Kumar and his associates have proposed the possibility of alkaline/saline wastelands acting as a significant autosink for trapping some of the atmospheric CO_2. In next three or four papers, effects of increased CO_2 on the process of photosynthesis and related processes in higher plants are discussed. Dr. singh and his associates have tried to analyse the effect of CO_2 enrichment in India's context.

The third section of the book deals with photosynthesis in relation to environmental stresses. The first paper in this section is the collaborative work of scientists from India and USSR, where they have synthesized tetromeric Mn clusters which had close analogy with the native WOC. This work has opened up the possibility of construction of artificial photosynthetic systems. In another paper, a chemical probe has been used which could decipher the role of Cl in oxygen evolving activity of PSII. Govindjee

has reviewed the information regarding the unique role of CO_2 in PSII. Golden and his associates have revealed that the D_1 and D_2 proteins of photosystem II reaction centre are encoded by two small gene families in the cyanobacterium *Synechococcus* sp., whose expression is dependent on light intensity. The next paper deals with the relationship between PSII activity and CO_2 assimilation in plants. These studies have demonstrated that light-dependent, non-photochemical quenching of excitation energy is an important factor determining the photochemical activity of PSII and consequently CO_2 assimilation. The current status of research in molecular genetics of PSI has been discussed in the next paper. Dr. Ort has attempted to give experimental evidence for the existence of an intricate mechanism (s) able to 'down regulate' photosynthetic efficiency as illumination levels exceed photosynthetic capacity. Dr. Tolbert has discussed the possibility of using algae for lowering atmospheric CO_2 as algal DIC pump has the potential to remove excess of CO_2. Dr. Lawlor has described the photosynthetic responses of plants to elevated CO_2. The next two papers deals with water relations, stomatal conductance and rate of photosynthesis etc as affected by different factors. The last paper in this section deals with the synthesis of heat shock proteins in *Vigna* by various heat shock mimicking agents.

The fourth section, comprising of three papers, deals with crop modelling. In the first paper, the authors from UK and Italy have applied well tested model for growth and development of wheat, for predicting changes in dry matter productivity as a consequence of increase in CO_2 and temperature. Based on the predictions, they have further defined crop ideotypes that will be better adapted to altered conditions. Dr. Hesketh and his colleagues from USA have discussed literature sources for plant morphology and phenology for developing generic plant models. Such models may predict the responses of plants to stressed associated with climate change. The limitations of steady-state gas exchange measurements, indicating the models based on steady-state rates of CO_2 assimilation, to over-estimate photosynthesis are discussed in the next paper.

The last section encompassing 18 papers deals with agro and natural eco-systems. The first paper delineates agroclimates for the whole of Indian subcontinent. The crop potential in different agroclimates are given for optimising the cropping pattern. The next paper describes the regional changes and model projections. This is followed by a paper in which existing remote sensing techniques to study plant growth processes at agricultural and agrometeorological spatial scales have been discussed. The potential impact of global climatic change in Himalaya is discussed in the next chapter. Primary productivity of Indian wetlands with regard to future scenario has been described by authors from BHU, India. The next chapter provides an estimate of Indian contribution to the global methane and nitrous oxide budget. Global methane cycle has been described in the paper by scientists from USA. Following this, three papers deal with the temperature stress effects on the performance of cotton, wheat and rice respectively. The factors responsible for driving global climatic changes and eco-systems are discussed in the ensuing paper. This is followed by two papers from USSR which discuss photosynthesis in relation to ecological regions, extra-polating to climatic evolution of plants. In the next paper, an attempt has been made to determine the effect of forest conversion on carbon storage in a dry tropical region. Effects of deforestation on climatic changes have been discussed in the next paper. The last three papers again deal with the photosynthesis and plant productivity as affected by high CO_2 and temperature.

The recommendations emerging from the workshop have been summarized sectionwise. The major research priorities in each area have also been identified, which could serve as a guide to research scholars and scientists interested to initiate work in the area of global warming. General recommendations have also been given in the end. The book ends with the list of participants and author index. The book is a storehouse of information on the impact of global climatic changes on plant productivity and will be a good addition to the libraries of institutes of higher learning.

—RANDHIR SINGH