A-5 Effects of Enhanced Ultraviolet-B Radiation Caused by Stratospheric Ozone Depletion on Plants

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An increase in solar ultraviolet radiation of wavelengths between 280 and 320 nm (UV-B) as a resulted of depleted stratospheric ozone concentrations has been much concern for terrestrial and marine phytoorganisms. In this project, deleterious effects of UV-B on agricultural crops and marine phytoplanktons were assessed with reference to ecological functions and the mechanism of injurious effects was elucidated in terms of action spectra of the ultraviolet radiation on the growth of cucumber plants.

1) The total biomass of cucumber plants from three cultivars irradiated at 244 and 381 mW m^{-2} $UV\text{-}B_{BE}$ for three weeks in phytotron showed reductions respectively by 14 to 49% and by 17 to 79% against control.

2) The specific leaf area (SLA) of cucumber plants decreased significantly by UV-B irradiation, reflecting increased thickness of leaves and thus allowing a less proportion of UV to reach sensitive organelles in methophyll tissue.

3) A field modulation system of UV-B, which yields an irradiance of UV-B at 150% of control irradiance, was developed. No significant effects of a two-month irradiation with the system were observed on the growth of 17 rice cultivars from different geographical regions of the world. This result suggested less influence of increased UV-B on crops than anticipated.

4) Measurements with a spectroradiometer for water column indicated that the penetration of UV-B radiation was higher in the open than the coastal water. Extinction coefficient of UV increased with a decrease in its wavelength and with chlorophyll a concentration. UV effective layer occupied 23-30% and 16-19% of the euphotic layer in the open and coastal water, respectively. Phytoplanktons in open water seemed to be affected severer damage than in the coastal water.

5) The photosynthetic activity and pigment concentration of marine phytoplankton were diminished by UV-B radiation. On the other hand, recovery of damaged cells of natural assemblages of phytoplankton was recognized in dark periods. However, its complete recovery was not always observed.

6) Comparison of species composition of natural assemblages of phytoplankton with previously published data suggested that phytoplankton cells may have capability to recover from damage caused by UV-B in the coastal water

7) Effects of UV-B radiation on red algae were observed in reduction of growth rate, decrease in photosynthetic pigments and increase in UV-absorbing compounds. These effects were largely dependent on algae species.

8) Action spectra of monochromatic UV-B irradiation on the growth of cucumber leaves showed remarkable reductions for shorter wavelengths than 300 nm.

9) Simultaneous irradiation of visible rays with monochromatic UV-B on cucumber leaves induced an alleviating effect at 300 nm and a significant enhance growth at 310 nm. At 290 nm, however, no compensating effect of visible rays was found. In addition, UV-A restored growth inhibition by UV-B.

10) The content of ascorbic acid, a kind of antioxidants in tissues, in leaves of cucumber increased gradually with the lapse of UV-B irradiation. It suggested an involvement of oxidative toxicity in the growth inhibition due to UV-B.