MEASUREMENT OF LIGHT SOURCES FOR PESTICIDE PHOTOLYSIS STUDIES USING THE LI-1800 PORTABLE SPECTRORADIOMETER

Application Note #115

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Understanding the environmental fate of pesticides is the main emphasis of the registration process required by the US Environmental Protection Agency (EPA) to ensure that the health and safety of the public is maintained. Photodecomposition studies are among those studies required under the *Pesticide Assessment Guidelines, Subdivision N*. The fate of a pesticide exposed to light is important, not only because of its effect on efficacy of the pesticide, but also because degradation products formed may be hazardous to man and the environment.

Solar radiation reaching the earth's surface is influenced by the presence of atmospheric gases that allow certain wavelengths of light to penetrate while others are absorbed. Atmospheric ozone provides a sharp cutoff of the shorter wavelengths below 300 nm in the ultraviolet (UV) region of the spectrum. UV radiation reaching the earth's surface is important because it contains sufficient energy to disrupt many chemical bonds (e.g. carbon-carbon bonds, 88 kcal/mole). Light at 300 nm has energy of 95 kcal/mole but decreases as wavelength increases, so that above 450 nm, light energy is less than 65 kcal/mole, below that required for most types of bond breakage.

Conducting photolysis studies in natural sunlight outdoors is the preferred method but it is difficult to reproduce results in time because of variable conditions (clouds reduce light intensity, day length changes with season, temperature fluctuations, etc.). Laboratory studies utilizing artificial light sources allow most parameters to be controlled much more precisely than can be obtained outdoors. Light intensities can be increased to speed up the photodegradation process of compounds that are slowly degraded. However, meaningful comparisons between experiments can only be made by careful measurements of intensity and spectral distribution of the artificial light source. While differences in intensity change the rate at which photoproducts are formed, differences in the wavelengths can alter the types of photoproducts formed. This is probably the single most important reason for accurate determination of the spectral quality of artificial light sources, that is, to ensure accurate extrapolation of laboratory results to those that would be obtained in the environment under natural light.

The LI-1800 Portable Spectroradiometer is an excellent instrument for the determination of the spectral distribution and the intensity of light sources over the range of 300-850 nm (optional 300-1100 nm). The LI-1800 can be operated on its internal batteries for approximately 6-7 hours of continuous use or with AC line voltage. The small size of the instrument ($6 \times 8 \times 14$") and portable operation allow the LI-1800 to be used in the field, in the greenhouse or inside a growth chamber. A 180° fully cosine corrected receptor is built into the LI-1800 that collects light incident on a flat plane. The instrument comes from the factory fully calibrated. To maintain the calibration accuracy of the LI-1800 an optional calibrator (1800-02) is available for laboratory recalibration, or the LI-1800 can be returned to the factory. All calibrations are fully traceable to the NIST. Where size constraints do not allow the entire instrument to be placed in the area to be measured, a remote cosine receptor (1800-11) with a fiber optic probe (1800-10) is available which can be inserted into spaces less than 1 inch wide. However, it is calibrated only over the range of 330-1100 nm. The LI-1800 is microprocessor-driven and can store scans in its internal memory for later transformations. Data can be dumped directly to a printer as graphic plots or numerical listing of data, or into a personal computer for further data manipulation or user-specific applications. With the software resident in the LI-1800, the operator can set up the instrument, make a scan, and plot the data on a dot matrix printer in as little as 5 minutes, all without an external computer.

Measurements of light sources (artificial or natural) can be made in 1, 2, 5, or 10 nm intervals and expressed in energy units (W m^{-2} nm^{-1}), quantum units (mmoles sec^{-1} m^{-2} nm^{-1}) or in photometric units (lux). Lamps can be monitored at frequent intervals to determine changes in intensity and spectral distribution that occur as lamps age. Using the resident LI-1800 software or the optional software for the IBM personal computers (1800-14), scans taken at different times can be divided by each other and plotted. If no changes in lamp output have occurred, a straight line plot equal to 1 will result. However, if the intensity or spectral quality of the lamp has changed, then the plot will no longer be equal to 1 or the line will not be straight. Alternatively, scans taken at different times could be plotted on the same graph and visually examined. Scans of different light sources can be compared in a similar manner, such as sunlight versus a xenon arc lamp. Dividing the two scans by each other will allow the researcher to quickly and quantitatively determine the differences in intensity of the two light sources, and by the peaks and valleys, the wavelength ranges where spectral quality is different.

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