INFLUENCE OF HUMIDITY AND RAIN ON UPTAKE AND METABOLISM OF $^{14}$C-AZINPHOS-METHYL IN BEAN PLANTS

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In several experiments the influence of relative humidity and rain on uptake and metabolism of carbonyl-$^{14}$C-azinphos-methyl was examined in bean plants under the following environmental conditions: Growth room with 35/80%, 65/85% and 95/95% (day/night) relative humidity and open field with and without rain. Increasing relative humidity had an enhancing effect on the rate of uptake and metabolism. A higher portion of water-soluble compounds was found in the bean tissue, although the azinphos-methyl itself is relatively non-polar. Low relative humidity and possible dry periods in summer will reduce the uptake and will leave the azinphos-methyl relatively persistent on the leaf surface. Rain or spray irrigation easily removed azinphos-methyl from the leaves. The rate of this removal seemed to depend on the intensity and time of rainfall after application. However, repeated wettings by rain may simultaneously stimulate uptake and metabolism of azinphos-methyl by the leaves.

Pesticides applied to plants or soil are exposed to certain environmental influences which may have an effect on their mode of action, uptake, and fate in plant and soil. Primarily the climatic factors (also termed "weathering") such as light, temperature, humidity, and wind seem to be important.

In numerous investigations it has been demonstrated that photodecomposition is of importance for the degradation of certain pesticides (Crosby 1969 and 1973, Hull 1970, Plimmer 1970). Light seems to stimulate or inhibit the uptake by plants depending on the plant as well as on the chemical properties of the respective pesticide (Hull 1970). High temperature and humidity generally improve the permeability of the cuticle resulting in an increased uptake of certain pesticides. Dew, mist, or drizzle influence the extent and intensity of uptake processes. On the other hand, pesticides are removed from the leaf surface by rain or wind. In addition, leaching of pesticides or their metabolites can occur (Crosby 1973, Hull 1970, Plimmer 1970).

With reference to the insecticide $S$-(3,4-dihydro-4-oxobenzo [d]-[1,2,3]-triazin-3-ylmethyl) dimethyl phosphorothiolothionate, (azinphos-methyl), little is known about

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the influence of environmental factors on persistence, degradation, uptake, and metabolism in plants. Only the effect of light, temperature, pH, formulation and mode of application has been investigated under more or less laboratory conditions (Crosby 1969, Schulz et al. 1970, Liang and Lichtenstein 1972). Previous investigations with 14C-azinphos-methyl showed differences in the metabolism of this insecticide, which seemed to be due to climatic factors, especially to humidity (Steffens and Wienke 1974, Wienke and Steffens 1975). Therefore additional experiments were conducted in a growth room and under open field conditions to study the influence of relative humidity and of rain on the fate of azinphos after application to bean leaves.

Materials and methods

In all experiments carbonyl-14C-azinphos-methyl was used. In a number of experiments this labelling position proved to be highly resistant against complete mineralization or respiration to 14CO2 by plants (Steffens and Wienke 1974, Wienke and Steffens 1975). Bean plants (Phaseolus vulgaris 'Saxa') were used as standard plant material. Details on standard cultivation, formulation, spray application, cleanup procedures, and thin layer chromatography are described elsewhere (Steffens and Wienke 1974, Wienke and Steffens 1975). Four hundred µg (in the field experiments, 500 µg) of azinphos-methyl with specific activities ranging from 3.7 to 8.0 µCi/mg were applied to the first trifoliate leaf. Experimental time was 14 days. Seven experiments were conducted in a growth room under these standardized climatic conditions: 12 hr photoperiod with one hr of adjustment each in the morning and evening, 14,000 Lux light intensity, day/night temperatures, 23°C/17°C. The day/night relative humidity varied as follows: two experiments at low humidity 35%/80%, two experiments at high humidity 95%/95%, and three experiments at medium humidity 65%/85%.

In August and September, 1973, in addition, four experiments were run in the open field, two of them in nutrient solution with rain or spray irrigation and two simultaneously in nutrient solution and soil without rain. The maximum temperatures ranged from 16.5°C to 31.8°C during the daytime and the minimum temperatures at night were from 2.8°C to 15.3°C. The respective values for the relative humidity were: 22 to 63% (minimum) during daytime and 92 to 95% (maximum) at night. During the experiments without rain one mm of precipitation was registered as dew. The water from rain or irrigation was collected quantitatively.

The following fractions were investigated for 14C and azinphos-methyl or its metabolites: Benzene strip from the leaf surface; rainwater; hexane, chloroform, and water fractions; the non-extractable residue from the treated leaf; and the non-treated plant parts.

Results and discussion

In table I the results of a number of experiments, carried out under different growth room or field conditions, are compared with those obtained from experiments conducted simultaneously under standardized environmental conditions. The trend of