Environmental Factors Affecting Dieldrin Uptake by Rye

by W. B. Wheeler
Pesticide Research Laboratory, Department of Food Science
Institute of Food and Agricultural Sciences, University of Florida
Gainesville, Florida

The absorption and translocation of some chlorinated hydrocarbon insecticides by agricultural crops has been demonstrated (1,2,3,4,5 and others). Certain of the factors which govern uptake have also been reported. These include the insecticide itself (2,3), the substrate composition (e.g. soil type) (5), insecticide level (2,3,5), and crop species (2,5). The influence of additional environmental factors has not been reported, to this author's knowledge.

This report will present data showing the effects of photoperiod, temperature and relative humidity on the uptake of dieldrin by rye grown in sand containing this compound.

Experimental

Rye (Secale cereale var. Gator) was grown in acid-washed white sand which contained 10 ppm dieldrin (99% HEOD, Shell Development Co.). The treated sand was poured into 4-inch, round, plastic pots, the seeds (25 per pot) were planted and an additional 1/4 inch of uncontaminated sand was used to cover the seeds. The pots were then covered with aluminum foil to prevent vaporization of dieldrin and placed in a saucer of tap water in growth chambers. After the rye had grown approximately 1 inch above the substrate, the aluminum foil was removed and the sand was covered with granular paraffin to prevent plant contamination by vaporized insecticide. Aerial portions of the plants were harvested 21-24 days after planting by cutting them 1 inch above the paraffin. Five pots of experimental plants and 2 pots of controls (no dieldrin in the sand) were grown simultaneously under each set of conditions. Each pot constituted one sample and each experimental system, maintained in a Sherer-Gillet Environmental Chamber, was replicated on three different occasions. Conditions of photoperiod, relative humidity and temperature are presented in Table I.

Dieldrin was extracted from rye by blending with n-hexane-isopropyl alcohol (2:1) (6). The extract in hexane was cleaned up by sweep co-distillation (Kontes-Sweep Co-Distillation Apparatus) on silanized glass wool (7) as modified: (1) the hexane extract was concentrated to give 1.0 to 2.0 gm crop per ml; (2) the heated (250°C) Storherr tube was pre-rinsed with 1 ml hexane; (3) 1.0 ml hexane (in 250 µl pulses)

FLORIDA AGRICULTURAL EXPERIMENT STATIONS JOURNAL SERIES NO. 3626.

containing crop was injected into the Storherr tube; (4) 1 ml hexane (in 250 μl pulses) was immediately injected; (5) the tube was rinsed with four 1 ml portions of hexane (250 μl pulses) at 3 minute intervals; (6) the Teflon tubing was rinsed with 1 ml hexane. This procedure gave consistent 90-95% recoveries of dieldrin from extracts fortified (0.05 - 0.50 ppm) prior to clean up.

TABLE I

Experimental Conditions of Photoperiod, Temperature and Relative Humidity

	Growth Chamber*				
	1	2	3	A	B
Hours light	8	16	16	16	16
Hours Dark	16	8	8	8	8
Temp. °F (light)	75	75	65	75	75
Temp. °F (dark)	65	65	55	65	65
Rel. Humidity (%)	70	70	70	75	54

* Nos. 1,2 and 3 were used to observe the effect of photoperiod and temperature. Nos. A and B were used to observe the effect of relative humidity.

The cleaned up extracts were analyzed using a Warner-Chilcott gas chromatograph equipped with an electron capture detector. The column was U-shaped glass, 5 feet x 1/4 inch and packed with 3% QF-1 on 80/100 mesh Gas Chrom Q. The column, vaporizer and detector temperatures were 175°C, 215°C, and 205°C respectively.

The means and variances for each set of data were calculated. A "t" test (8) was applied to determine if the mean uptake by rye grown under one set of conditions was significantly different than the mean uptake from a second set of conditions.

Results

All plants appeared in good condition throughout the growing period. The weights of the plants grown under varying conditions were approximately the same (± 15% of the mean) and the various environments did not appear to significantly alter growth.

The levels of dieldrin detected in rye grown under differing environmental conditions are summarized in Table II.

TABLE II

Effects of Photoperiod, Temperature and Relative Humidity on Dieldrin Uptake by Rye

Experimental Conditions[a]	Ppm Dieldrin in Rye[b]
Long day	0.11[c]
Short day	0.13[c]
75°	0.11[c]
65°	0.14[c]
High humidity	0.07[d]
Low Humidity	0.16[d]

a. Specific conditions are presented in Table I.
b. Based on fresh weight of crop. Dieldrin levels detected in rye grown in pots containing no dieldrin were subtracted from experimental values.
c. No significant difference (95% confidence level) between this and the other paired value.
d. Highly significant difference (99.5% confidence level) between this and the other paired value.

Effect of Photoperiod: The mean dieldrin uptake under experimental conditions 1 and 2 were 0.13 ppm and 0.11 ppm respectively. The means were not statistically different at the 95% level of confidence.

Effect of Temperature: In a similar manner the mean dieldrin uptake under conditions 2 (0.11 ppm) and 3 (0.14 ppm) were compared. Again, the means were not significantly different (95% confidence level).

Effect of Humidity: The mean uptake values for rye grown under conditions of high relative humidity and low relative humidity were 0.07 ppm and 0.16 ppm dieldrin respectively. The value of "t" derived from these data indicates that these two average levels of dieldrin in rye are significantly different (99.5% confidence level).

Discussion

Relative humidity significantly affected dieldrin uptake by rye under controlled environmental conditions. Further, the lack of influence of temperature and photoperiod suggests that the process of uptake is passive in nature rather than one which requires the plant to expend energy in order to absorb the insecticide. Dieldrin, very slightly water soluble, is probably carried into tissues with water and is trapped, perhaps in membranes, as the water passes out of the plant. The data support this theory. Low relative humidity of the air surrounding the crops would create a much higher moisture gradient between internal rye tissues and the surrounding atmosphere than would be the case if the air possessed a high relative humidity. The former condition should cause more water to move through the plants and more dieldrin to be carried with it and be subsequently trapped by the tissues.

The rye used is not sensitive to photoperiod in the classic sense (i.e. controlling the onset of flowering, etc.) and the effect on a plant which is photoperiod-sensitive may be different.

It is possible that photoperiod and temperature do influence dieldrin uptake to a lesser extent than relative humidity but the methods utilized could not detect these effects. Other potential environmental influences should be investigated, especially as they relate to crop contamination (external and internal) from soil residues with the goal of reducing the potential hazard of above-tolerance levels in crops.

Acknowledgement

The technical assistance of Caroline E. Honse is acknowledged.

This research was supported in part by U. S. Public Health Service Grant ES-00208 from the Division of Environmental Health Sciences.

References

1. Decker, G. C. and Bruce, W. N., Abstracts of Papers, Division of Agricultural & Food Chemistry, 150th Meeting, ACS, p. 18A (1965)
2. Lichtenstein, E. P., J. Agr. Food Chem. 8, 448 (1960)
3. Lichtenstein, E. P. and Schutz, K. R., J. Agr. Food Chem. 8, 452 (1960)
4. Morley, H. V. and Chiba, M., Can. J. Plant Sci. 45, 209 (1965)
5. Wheeler, W. B., Frear, D. E. H., Mumma, R. O., Hamilton, R. H. and Cotner, R. C., J. Agr. Food Chem. 15, 231 (1967)
6. Wheeler, W. B., Frear, D. E. H., Mumma, R. O., Hamilton, R. H. and Cotner, R. C., J. Agr. Food Chem. 15, 227 (1967a)
7. Storherr, R. W. and Watts, R. R., J. Assoc. Offic. Agric. Chemists 48, 1154 (1965)
8. Dixon, W. J. and Massey, F. J.,Jr., Introduction to Statistical Analysis, p. 121, 2nd ed. (1957), McGraw-Hill, New York