Inhibitory Effects of the Insecticides Allethrin, Lindane, and Jacutin-Fogetten Sublimate on Photosynthetic Electron Transport

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The inhibitory effects of the insecticides Allethrin, Lindane, and Jacutin-Fogetten sublimate on photosynthetic electron transport of broken chloroplasts were tested. 50 μmol l^{-1} Allethrin caused an inhibition of 80% of the benzoquinone and ferricyanide Hill-reactions. 39 μmol l^{-1} Lindane inhibited the basal, coupled and uncoupled electron transport to ferricyanide up to 35%. The precipitate formed by the sublimation of Jauctin-Fogetten containing Lindane depressed electron transport much more than pure Lindane. 50 μg ml^{-1} of the sublimate led to an 80% inhibition of ferricyanide Hill-reaction.

Introduction

During our studies of Hill-reactions and photophosphorylation of isolated chloroplasts we observed an inhibition of electron transport after an application of the smoke of Jacutin-Fogetten in the plant growth chamber. Therefore we tested the influence of the sublimate formed by the fumigation of Jacutin-Fogetten as well as of the insecticides Lindane and Allethrin on the photosynthetic electron transport reactions of PS II and PS I.

Materials and Results

Jacutin-Fogetten is the trade name (Merck) of a fumigant which is used for killing insects in buildings. The product contains 53% Lindane (lable of the package).

Lindane (Gammexan) is the name for the γ-isomer of hexachlorcyclohexane (see [1] for review). It acts on animals especially through the respiratory system, but also through the body surface and when it is taken up with food. Lindane is taken up through the leaf surface and then causes a kind of an insecticide depth effect.

Allethrin belongs to a group of insecticides of natural origin. Insecticides prepared from plant material have been used for many years. Especially the pyrethrins were of considerable importance in practical use. Allethrin was the first pyrethroid which could be prepared synthetically. In commercial products its stability and insecticide activity is improved by stabilizers and synergistic agents. The product used in our experiments was purchased from ICN Life Sciences Group.

Chloroplasts were isolated from plants of *Pisum sativum*. The methods for the determination of Hill-reaction activities were described previously [2, 3].

39 μmol l^{-1} Lindane inhibits the basal, coupled and uncoupled electron transport to ferricyanide of broken chloroplasts isolated from leaves of *Pisum sativum* up to 35% (Fig. 1). A higher inhibitory effect with higher concentrations is limited by the low water solubility of Lindane. On the contrary Lindane stimulated the PS I activity measured with methylviologen as electron acceptor and the ascorbate/dichlorophenolindophenol donor system.

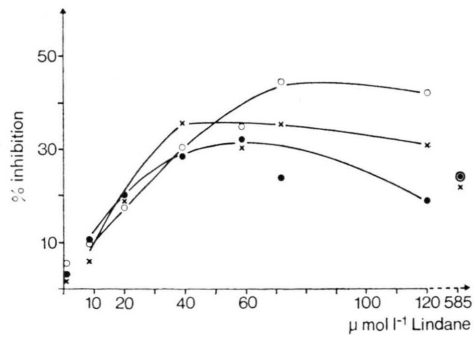

Fig. 1. Inhibitory effects of Lindane on the basal (○——○), coupled (×——×) and uncoupled (●——●) photosynthetic electron transport measured as ferricyanide reduction.

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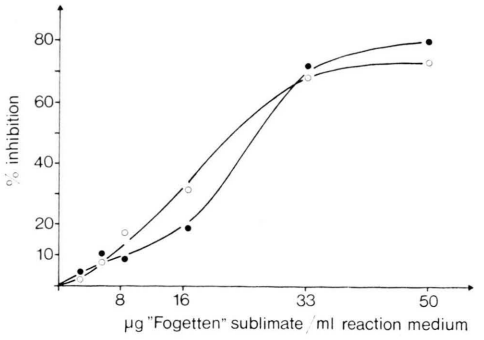

Fig. 2. Inhibitory effects of Jacutin-Fogetten sublimate on the coupled (○——○) and uncoupled (●——●) electron transport measured as ferricyanide reduction.

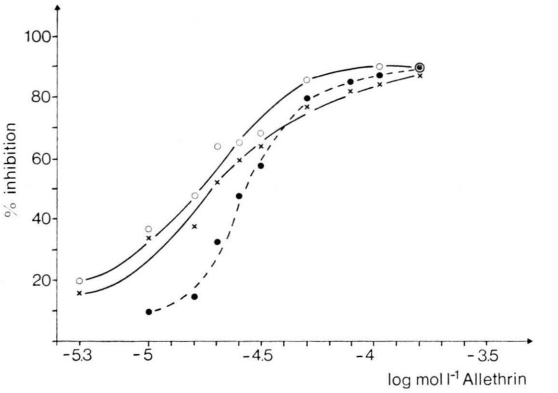

Fig. 3. Inhibitory effects of Allethrin on the benzoquinone Hill-reaction (×——×) and on the coupled (○——○) and uncoupled (●——●) ferricyanide Hill-reaction.

The inhibitory effect of Jacutin-Fogetten sublimate is shown in Fig. 2. The precipitate formed by the sublimation of the Lindane containing Jacutin-Fogetten depresses electron transport much more than pure Lindane. 50 μg of the sublimate per ml reaction medium causes an inhibition of 80% of the coupled and uncoupled ferricyanide Hill-reaction. Thus we believe that a decomposition product of Lindane exists in the sublimate which strongly inhibits the electron transport. In the gas chromatogram of Jacutin-Fogetten sublimate several smaller peaks appear before the Lindane-peak.

50 μmol l^{-1} Allethrin causes an inhibition of 80% of the benzoquinone and ferricyanide Hill-reactions. The coupled and uncoupled electron transport to ferricyanide shows an inhibition of 50% at the concentrations of 17 μmol l^{-1} ($pI_{50} = 4.77$) and 27 μmol l^{-1} ($pI_{50} = 4.57$) respectively. With benzoquinone as the electron acceptor 50% inhibition is reached with 19 μmol l^{-1} ($pI_{50} = 4.72$). The PS I activity with methylviologen as an acceptor is not influenced by Allethrin. (In spite of our first working hypothesis, Allethrin is not contained in the Jacutin-Fogetten as shown by gaschromatography.)

[1] R. Wegler, Chemie der Pflanzenschutz- und Schädlingsbekämpfungsmittel, **Vol. 1,** Springer-Verlag, Berlin-Heidelberg-New York 1970.

[2] A. Wild, A. L. Oberweis, and W. Rühle, Z. Pflanzenphysiol. **82,** 161–172 (1977).

[3] K. Bauer and A. Wild, Z. Pflanzenphysiol. **80,** 443–454 (1976).