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VOLATILIZATION OF GAMMA-BHC AT TROPICAL TEMPERATURE

(Miss) NASIMA KHAN, (Miss) SHAMIM FERHAT, M.M.H. BAIG and K.A. LORD*

Toxicology and Pesticides Laboratory, Department of Plant Protection, Karachi 27

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Abstract. Gamma-BHC emulsion was sprayed on rice plants and residues tested by gas chromatography. Results indicated rapid loss of insecticide from the plants as very little quantity was found on them after 3 hr. Volatilization, therefore, appears to be the possible cause of loss. This suspicion was confirmed when small quantities of gamma-BHC, in n-hexane, was applied onto glass cover-slips, washed and assayed and found that evaporation rate was dependent upon surface area. BHC emulsion is, therefore, unlikely to give prolonged protection to plants.

The repeated insecticide treatments necessary to control insects, specially stem borers which attack paddy, are costly and liable to leave residues. Chemical assay of insecticide remaining on the crop may help to diminish both cost and dangerous residues by determining persistence on crops. However, persistence depends upon climate and little work has been done in Pakistan to investigate this aspect.

We chose to study the persistence of gamma-BHC on paddy because it is produced locally in Pakistan and its use alone or in combination with carbaryl is growing in the country. Moreover, it is one of the standard insecticides being successfully used by the International Rice Research Institute, Manila, for paddy borer control.[1]

Experimental

Gamma-BHC in solution was assayed by gas chromatography on a column packed with SE 30 silicon gum on Phasesep W using nitrogen as a carrier gas and an electron capture detector.

Loss from Rice Plants. Rice seedlings, 15–20 cm tall, growing in river-bed soil 2 or 3 in a polythene bag, were sprayed with a small Chinese paint spray gun using 1 ml of a 0.1% aqueous emulsion of gamma-BHC for each bag. The emulsion was made by diluting with water a concentrate prepared from 3 g CM-753 emulsifier,† 1 g Waxoline red-dye and 25 g gamma-BHC in 100 ml xylol.

Insecticide was determined immediately after spraying and then after 3 and 24 hr at each time 3 lots of plants were analysed. The plants were kept away from direct drafts in a laboratory at 80–90°F.

All the plant material from a bag was used for a single analysis. Insecticide was washed, from the plant surface with 9 ml hexane using 3 Successive portions of 3 ml. It was derived by passing through anhydrous Na_2SO_4. To assess the penetration of the insecticide, the plants were then extracted by cutting into 2-cm lengths and grinding with 10 ml n-hexane–acetone (2:1) mixture in all-glass homogenisers. extracted from the plants which interfered with the assay of gamma-BHC by gas chromatography.

In one test 2.5 p.p.m. of BHC was washed from the plants immediately after spraying but only 0.4 p.p.m. remained 3 hr later and 0.04 p.p.m. after 24 hr. After washing BHC from the surface of plants they were extracted and the BHC found in the plants increased from 0.01 p.p.m. at the time of spraying to 0.04 p.p.m. 3 hr later but fell to 0.005 p.p.m. after 24 hr. The test was repeated 3 times and on each occasion there was a rapid loss of BHC from the plants. Because so little BHC was found in the plants it is unlikely that BHC sprayed onto plants has any systemic action, although it is possible that the insecticide penetrated into the plant and was decomposed. However, at least some decomposition products should have been detected by electron capture gas chromatography which is very sensitive to chlorinated hydrocarbons, but none were found. There remained another possibility of volatilisation of BHC from the plants which, if sufficiently rapid, would mask a slower penetration into the leaves and conceal any possible systemic effects of BHC.

Loss from Glass. To avoid possible metabolism of BHC by rice seedlings, evaporation of BHC from glass surfaces, known to be inert, was examined. For accuracy, drops of BHC solution were measured onto glass cover slips, used because they can be conveniently and rapidly washed in a quantitative fashion. In one test, loss of gamma-BHC from glass cover slips was determined 1, 2 and 3 hr after applying 2 microlitre drops of solution containing one microgram gamma-BHC to the cover slips. The residual gamma-BHC was washed from each cover slip by putting it in a 5×2.5 cm tablet tube with 1 ml n-hexane. The remaining gamma-BHC was assayed by gas chromatography. The amount of BHC remaining (mean from 5 replicates) after 1 hr was 25%, after 2 hr 14% and after 3 hr 3–4%. In another test, loss of BHC was determined at 5 min intervals and rapid loss of BHC was again observed (Fig. 1). The unreplicated determinations showed considerable scatter (Fig. 1) which seems to be the result of the variable spread of the BHC on slides because it was noticed that those drops which showed least loss and gave apparently anomalous results (Fig. 1) were much more compact than the others. After 1 hr the amount remaining

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†Manufactured by Chemical Materials Ltd., N. S.W., Australia.

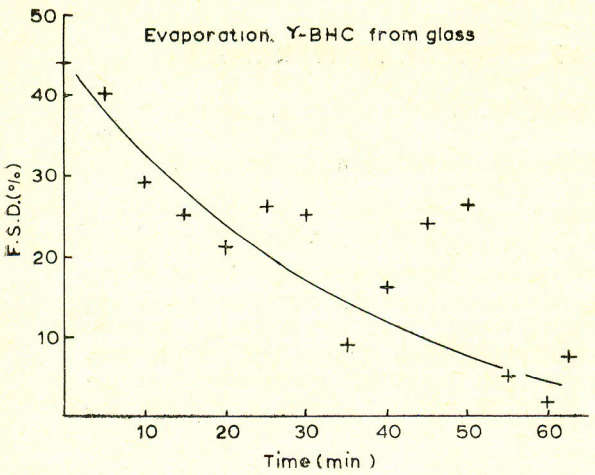

Fig. 1. 2 ml drops of hexame containing 1 ml Y-BHC were applied to coverslips left uncovered and away from draughts.

The extract was washed with 2% sodium sulphate, the n-hexane layer separated, concentrated and passed through a silica gel column to remove substances (resulting from the most widely spread drops) is 5–10% (Fig. 1) by comparison with the mean of about 25% found in the other test.

To check this observation that loss increased with the spread of drops, 5 and 10 microlitre drops of n-hexane containing 1 microgram gamma-BHC were placed on cover slips. The gamma-BHC remaining on cover slips was assayed after 30 min when 9/10th of the gamma-BHC was lost from the 5 microlitre drops, and none was recovered from the 10 microlitre drops. Half the BHC was recovered from 2 microlitre drops. In contrast, when 10 microgram BHC was applied on cover slips in 2 microlitre of n-hexane, the 10% loss which might be expected from the tests with 1 microgram of BHC was too close to the combined experimental errors of drop measurement, and assay, to be measured.

Conclusions

As no decomposition products of gamma-BHC are found in the washings from cover slips and glass is known to be inert, it is unlikely that there was any catalytic decomposition so that loss by evaporation is most likely, in view of the volatility of BHC reported by Barlow and Hadaway[2] and Hancock and Laws.[3]

The close relation of loss of insecticide with the size of drops also supports this conclusion as the rate of evaporation is dependent upon surface area.

Thus, the tests with loss from glass surface support the conclusion that BHC sprayed onto rice plants is rapidly lost by volatilization, little enters the plant. Because loss of BHC from the leaf surface is so rapid there is little time for the insecticide to be taken into the plant and spraying with BHC emulsion is unlikely to give prolonged protection.

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