MULTIPLE RESISTANCE IN ANOPHELES CULICIFACIES GILES

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ABSTRACT. A population of Anopheles culicifacies from Maharashtra State, India, showed a broad spectrum of organophosphate resistance when compared with populations of the same species from Sri Lanka and Pakistan. Of significance is the resistance to a number of organophosphates considered potential candidate alternatives for vector control in public health programmes. All 3 populations were susceptible to fenithion and the carbamate, propoxur. DDT resistance was common to all 3 populations. Dieldrin resistance was confined to the two populations from India and Pakistan.

Organochlorine resistance is already widespread in Anopheles culicifacies. According to WHO (1980) DDT resistance is present in Afghanistan, Burma, India, Iran, Nepal, Pakistan and Sri Lanka while dieldrin resistance has been recorded in Afghanistan, India, Nepal, Oman and Pakistan. Malathion resistance in An. culicifacies was first detected in Gujarat State in India in 1973 (Rajagopal 1977). It is now apparently present also in the Warangal District of Andhra Pradesh according to data provided by Rao (1979). In addition Herath et al. (1981) have now demonstrated fenitrothion resistance in this species from both the Maharashtra and Gujarat States of India.

This paper compares the response shown by 3 populations of An. culicifacies from Sri Lanka, Pakistan and India to a number of insecticides including organochlorines, organophosphates and carbamates.

MATERIALS AND METHODS

The Anopheles culicifacies populations used were:

CUL/SRI—a population derived from eggs received from Atanagalla, Kirindiwela, Sri Lanka, and supplied by the

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food. Quantities of food were carefully adjusted according to the larval density and stage of development so as to ensure the production of uniform-sized larvae, pupae and emerging adults. Adult males had access to approximately 20% glucose solution while the females were fed on blood in addition. Feeding was mainly on human volunteers as most were reluctant to feed on the normal animal host provided, the guinea-pig. Both the Sri Lankan and Indian populations had to be propagated by the artificial mating technique as neither mated naturally in cages. The Pakistan population was the cage-adapted one reported by Ainsley (1976).

Susceptibilities to the insecticides were determined by the standard WHO adult susceptibility test using less than 1 day old males and unfed females. One hr exposures, followed by 24 hr recovery periods, were made to concentrations considered to discriminate susceptibility from resistance though, as will be seen, some of these concentrations were imperfect in this respect.

RESULTS AND DISCUSSION

Mortalities after exposure to the organochlorines, 8 organophosphates and 1 carbamate are given in Table 1. All 3 populations are highly resistant to DDT, but while the Pakistan and Indian populations show dieldrin and HCH resistance, the Sri Lankan one remains susceptible to these insecticides. All 3 populations seem equally susceptible to fenitrothion and propoxur. When comparisons are made with mortalities in the Sri Lankan and Pakistan populations it would seem that resistance to malathion, malaaxon, fenitrothion, chlorthion, chlorphoxim, iodophenophos and pirimiphos-methyl is present in the Indian population.

This resistance to almost all the candidate organophosphate insecticides shown by the Indian population could be of serious practical significance. What needs to be established with some urgency is the level, extent, and operational implications of these resistances. From the susceptibility tests carried out so far it would seem that propoxur remains a suitable alternative if needed. Fenithion is not now considered suitable for house-spraying because of its high mammalian toxicity.

ACKNOWLEDGMENTS

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Table 1. Percentage mortalities at discriminating dosages of various insecticides shown by the Indian population

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>CUL/SRL</th>
<th>CUL/PA</th>
<th>CUL/IND</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% malathion</td>
<td>99 (81)</td>
<td>95 (92)</td>
<td>2 (215)</td>
</tr>
<tr>
<td>5% malaaxon</td>
<td>100 (87)</td>
<td>100 (10)</td>
<td>33 (36)</td>
</tr>
<tr>
<td>1% fenitrothion</td>
<td>96 (110)</td>
<td></td>
<td>7 (214)</td>
</tr>
<tr>
<td>0.1% chlorthion</td>
<td>92 (152)</td>
<td></td>
<td>37 (27)</td>
</tr>
<tr>
<td>4% chlorphoxim</td>
<td>97 (89)</td>
<td>100 (140)</td>
<td>37 (65)</td>
</tr>
<tr>
<td>10% iodophenophos</td>
<td>100 (17)</td>
<td></td>
<td>50 (22)</td>
</tr>
<tr>
<td>1% pirimiphos-methyl</td>
<td>90 (94)</td>
<td>95 (42)</td>
<td>4 (119)</td>
</tr>
<tr>
<td>2.5% fenithion</td>
<td>95 (38)</td>
<td>100 (34)</td>
<td>90 (114)</td>
</tr>
<tr>
<td>0.1% propoxur</td>
<td>100 (28)</td>
<td>100 (44)</td>
<td>100 (63)</td>
</tr>
<tr>
<td>4% DDT</td>
<td>12 (445)</td>
<td>0 (72)</td>
<td>7 (90)</td>
</tr>
<tr>
<td>4% dieldrin</td>
<td>0 (16)</td>
<td>0 (6)</td>
<td></td>
</tr>
</tbody>
</table>

*CUL/SRL was exposed to 0.4% dieldrin.*
from the British Medical Research Council.

References Cited


ENGINEERING EVALUATION OF COMMERCIAL BACKPACK SPRAYER/DUSTERS¹

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ABSTRACT. Engineering evaluation of 9 commercial backpack sprayer/dusters was conducted by the U.S. Army in view of determining suitability to meet military needs. Important items included in the testing were reliability and ease of maintenance of the individual units, and determination of the pesticide dispersion rates. The most desirable characteristics of the sprayer/duster are also presented.

Disease vector control requires the use of a variety of liquid and solid insecticide formulations. These insecticides often must be dispersed effectively in small areas inaccessible to vehicle-mounted equipment. One means of accomplishing this is by small, motor-driven, backpack insecticide dispersal units. The U.S. Government emphasizes the use of available commercial units to meet the needs of the Army, rather than the development of unique items at Government laboratories. The selection of commercial units which meet the requirements of the Army is essential to this effort. An analytical tool for this determination is engineering evaluation of various commercial units to test relative suitability for military use.

Sixteen characteristics of 9 commercial backpack sprayer/dusters manufactured and/or distributed in the U.S. were evaluated. Units incapable of dispersal of both liquid and solid formulations were not included in this evaluation. Prior to testing units were weighed both with and without insecticides and fuel. Operating and storage dimensions were taken to determine the effect the addition of the item to the inventory would have on organizational mobility. After these pre-operative checks, units were operated and maintained in accordance with their instruction manuals for 250 hr. During this time, fuel consumption was determined. Insecticide tank capacity for liquid and solid formulations was measured. Flow rates and dispersal capabilities for each formulation were also determined. During the 250 hours of reliability testing, the number and type of failures were recorded. All maintenance testing, both for routine services and malfunction repair, was recorded. At the end of testing a

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