

SUSCEPTIBILITY OF *ANOPHELES MACULIPENNIS* TO INSECTICIDES IN IRAN, 1977¹

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ABSTRACT. *Anopheles maculipennis* Meigen is the chief or sole malaria carrier in the Caucasus and in northern Iran. The susceptibility level of adult female *An. maculipennis* to insecticides was studied in field surveys, in different localities of Iran, during 1970-77. Tests

were carried out in localities where the application of DDT for malaria control has been withdrawn since 1968. The studies showed that *An. maculipennis* is resistant to DDT but susceptible to dieldrin and malathion in Iran.

INTRODUCTION

In Iran, *Anopheles maculipennis* Meigen, is widely distributed in the Caspian littoral and Azerbaijan, it is also present in Khorasan, Teheran area, Isfahan and

Kermanshahan provinces. The only vector present in the Caspian littoral is *An. maculipennis*, whereas *An. maculipennis* and *An. superpictus* are the main malaria vectors in the Central Plateau.

Adults usually rest in human dwellings, stables, black tents, etc. Activity starts in June and ends in October, with only one peak in August.

The susceptibility level of *An. maculipennis* to insecticides has been fully

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summarized by Brown and Pal (1971) who stated that this species is resistant to DDT in Greece and Romania, and to dieldrin in Bulgaria and Romania. Ramsdale (1973) reported double resistance to DDT and dieldrin in Turkey. In recent years, agricultural pesticides including organochlorine insecticides have been used on a number of crops.

Susceptibility tests carried out in different localities in Iran showed that this species is resistant to DDT but susceptible to dieldrin and malathion. The objective of the present paper is to summarize and discuss briefly the field investigations concerning insecticide resistance in *An. maculipennis*.

MATERIALS AND METHODS

All tests were carried out using a field population of blood-fed adult female *An. maculipennis* collected by aspirator from indoor resting places between 06.00 and 08.00 hours.

The method used in testing was that developed by the World Health Organization (WHO 1970). Paper impregnated with DDT in Risella oil at concentrations of 1.0, 2.0 and 4.0%, dieldrin impregnated paper at concentrations of 0.1, 0.2, 0.4, 0.8 and 1.6% and malathion impregnated paper at concentrations of 3.2 and 5.0% were provided by WHO. For the controls, paper impregnated with Risella oil alone was used. All observed mortality was corrected by Abbott's formula when necessary. LC50's were estimated by plotting the dosage mortality lines.

RESULTS AND DISCUSSION

To obtain the base-line values of LC50 (%) on adult *An. maculipennis*, tests for DDT susceptibility were carried out in the unsprayed village of Ateshgah in Isfahan province in October 1955. The LC50 of DDT was found to be 1.6%. In subsequent susceptibility tests conducted on *An. maculipennis* in Isfahan city along the Zayeroud River where DDT spray

had not been applied, the LC50 of DDT was observed to be 2.6% in September 1956. Tests performed in the untreated village of Beheshtabad in the Ardal area of the Isfahan region showed the LC50 of DDT to be 1.45% in August 1957 (Mofidi et al. 1958).

In the village of Baghkoumeh, which had been sprayed for 4 years, the LC50 of DDT was observed to be 0.8% in September 1955. Tests were also carried out in September 1956 in the villages of Baghkoumeh and Sahlavan (Isfahan area), which had been sprayed for 5 consecutive years with DDT, and the LC50 of DDT obtained was 3.2 and 3.6%, and of dieldrin 0.2%.

DDT tolerance increased greatly in autumn, when fat bodies were observed in *An. maculipennis*. In the unsprayed city of Isfahan, the LC50 of DDT increased from 1.0% in August to 6.0% in October 1957.

The results of susceptibility tests on *An. maculipennis* with DDT in various localities where DDT house spraying of this insecticide has been withdrawn since 1968, are carefully watched. The LC50 of DDT in Flavarjan and Mobarakeh (Isfahan county), Central Plateau, in August 1970 was 2.8% and 3.7% respectively (Table 1). In tests made in July 1971 at Akhoondmahaleh (Shahsavari county) and Didoo (Sari county) in the Caspian littoral, northern Iran, the mortality rate with 4.0% DDT after 1 hr exposure was 31.9 and 63.9% respectively.

In tests made in July 1977 at Kolfir, Khanbaz (Meshgin-shahr county) and Nowdooz (Ahar county) in the province of Azerbaijan, northwestern Iran, the mortality rates with 4.0% DDT were 53.9% and 58.4% respectively after 1 hr exposure. Susceptibility tests carried out in July 1977, at Bijarbin, Shileh-sar (Astara county) and Luleman, Zardabmahaleh (Lahijan county) in the Caspian littoral, showed that the mortality rates with 4.0% DDT, 1 hr exposure and 24 hr recovery, were 71.4% and 80.3% respectively.

As shown in Table 2 the LC50 of diel-

Table 1. Results of DDT susceptibility tests on *An. maculipennis* in Iran, 1970-77.

Locality	Date	Spraying cycle	% Mortality after 1 hr exposure, 24 hr recovery					LC50
			Control	1.0% DDT	2.0% DDT	4.0% DDT		
Flavarjan (Isfahan)	August 70	4 DDT	0 (77)*	2.2 (85)	20.7 (82)	75 (88)	2.8	
Mobarakeh (Isfahan)	"	"	0 (83)	3.2 (93)	12.6 (87)	53.3 (90)	3.7	
Didoo (Sari)	July 71	8 DDT	0 (79)	1.4 (73)	33.3 (81)	63.9 (69)	3.2	
Akhoond-mahaleh (Shahsavari)	"	10 DDT	0 (93)	0 (94)	23.3 (98)	31.9 (92)	—	
Kolfir (Meshgin-shahr)	July 77	6 DDT 1 DL	0 (103)	0 (100)	0 (101)	53.9 (99)	3.8	
Khanbaz (Meshgin-shahr)	"	"	0 (103)	0 (99)	1.8 (106)	56 (107)	3.6	
Nowdooz (Ahar)	"	"	0 (100)	0 (98)	5.8 (103)	58.4 (98)	3.7	
Bijarbin (Astara)	August 77	8 DDT	0 (98)	4.8 (89)	23.7 (97)	71.4 (92)	3.0	
Shileh-sar (Astara)	"	9 DDT	0 (98)	7 (91)	41 (94)	80 (94)	2.2	
Luleman (Rasht)	"	13 DDT	0 (104)	8.9 (92)	26 (96)	80.3 (95)	2.3	
Zardab-mahaleh (Lahijan)	"	12 DDT	0 (101)	5.8 (96)	22.7 (97)	74.5 (96)	3.0	

* The figures in parentheses represent the number of mosquitoes tested.

Table 2. Results of dieldrin susceptibility tests on *An. maculipennis* in Iran, 1971-77.

Locality	Date	Spraying cycle	% Mortality after 1 hr exposure, 24 hr recovery						LC50
			Control	0.1*	0.2*	0.4*	0.8*	1.6*	
Ahmadabad (Isfahan)	July 71	9 DDT	2.4 (83)**	28.7 (66)	84.6 (65)	100 (74)	—	—	0.13
Siah-cheshmeh (Makoo)	"	1 DDT	0 (20)	—	18.5 (127)	76 (125)	89.4 (119)	100 (120)	0.35
Soltanabad (Kalat-naderi)	July 72	6 DDT	0 (104)	16.4 (97)	83.3 (99)	99 (105)	100 (100)	—	0.15
Hosein-kord (Gorgan)	"	9 DDT	0 (101)	3.7 (106)	58.1 (86)	92.2 (103)	100 (106)	—	0.18
Tooskestan (Gorgan)	"	8 DDT	0 (97)	6 (102)	31 (100)	92.6 (95)	100 (101)	—	0.29
Nowdooz (Ahar)	July 77	6 DDT 1 DL	0 (101)	—	2.9 (102)	25 (100)	99 (103)	100 (101)	0.45
Kolfir (Meshgin-shahr)	"	"	0 (102)	—	3.9 (101)	35.7 (104)	94.2 (104)	100 (102)	0.45
Balanka (Roodsar)	August 77	8 DDT	0 (101)	13.7 (103)	46.9 (101)	72.2 (102)	100 (101)	—	0.21

* % dieldrin.

** The figures in parentheses represent the number of mosquitoes tested.

Table 3. Results of Malathion susceptibility tests on *An. maculipennis* in Iran, 1970-77.

Locality	Date	Spraying cycle	%Mortality after 1 hr exposure, 24 hr recovery		
			Control	3.2%*	5.0%*
Flavarjan (Isfahan)	August 70	4 DDT	0 (94)**	100 (98)	—
Ahmad-abad (Isfahan)	"	9 DDT	0 (86)	100 (90)	—
Kolfir (Meshgin-shahr)	July 77	6 DDT	0 (100)	100 (100)	100 (102)
Khanbaz (Meshgin-shahr)	"	"	0 (103)	100 (101)	100 (102)
Nowdooz (Ahar)	August 77	"	0 (101)	100 (101)	100 (100)
Zardab-mahaleh (Lahijan)	"	8 DDT	0 (104)	100 (98)	100 (99)
Balanka (Roodsar)	"	13 DDT	0 (102)	100 (97)	100 (101)
Soltanabad (Kalat-naderi)	"	12 DDT	0 (98)	100 (98)	100 (101)

* % malathion.

** The figures in parentheses represent the number of mosquitoes tested.

drin for *An. maculipennis* in Ahmad-abad (Isfahan County) and Siah-cheshmeh (Makoo County) in the provinces of Isfahan and Azerbaijan was found to be 0.13 and 0.35% respectively, in July 1971. Also, the LC50 of dieldrin in Soltanabad (Kalat-naderi County) and Hosein-kord, Tooskestan (Gorgan County), northeastern Iran, was 0.15 and 0.29% respectively. In tests carried out in 1977 in Nowdooz, Kolifir and Balanka (Roodsar County) in the Caspian littoral, the mortality rates with 0.8% dieldrin after 1 hr exposure were 99%, 94% and 100% respectively. LC50 values are given in Table 2.

Tests carried out in August 1970 in 8 localities showed that the discriminating concentration that gives 100% mortality

was 3.2% malathion, 1 hr exposure, 24 hr recovery (Table 3).

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