

MULTIRESISTANT GERMAN COCKROACHES IN RUSSIA

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INTRODUCTION

Currently, insecticide resistant populations of *Blattella germanica* (L.) have formed in countries with different levels of economic development. The studies conducted both in Russia and abroad show that the spectrum of cockroach resistance to insecticides, e.g. in hospitals may be very different from those in the apartments, food markets and restaurants.

MATERIALS AND METHODS

- Six German cockroach wild strains from Moscow (M1, M3, M4, M5, M6, and M7), one strain from Obninsk, Kaluga region (OBN), and 4 from Ekaterinburg, Ural region (U1, U2, U3, U4) were used in the study. The average weight of males amounted to 48-55 mg / individual.
- All experiments were performed in comparison with the S-NIID susceptible laboratory strain.
- **The topical bioassay method** Topical applications were made in 1 μ L volumes on adult male cockroaches 1-4 weeks old.
- **Vial LT bioassays** Bioassays were conducted in glass tubes (dose - 20 μ g a.i./cm²).
- **Insecticide baits bioassay** were carried out with no-choice experiments. It was determined the index LT₅₀, (days), and RR.

RESULTS

- From 2014 to 2017, we have been topically monitored the insecticide susceptibility of male German cockroaches *Blattella germanica* from Moscow, Obninsk, and Ekaterinburg. It was found that all cockroach populations are most resistant to pyrethroid insecticides, especially cypermethrin (3 - >4000 \times). A number of the cockroach populations exhibited resistance to fipronil (10-54 \times). Tolerance or resistance to organophosphates (3-15 \times) are found in six Moscow, four Ural and Obninsk cockroach populations. At the same time, these populations exhibit weak tolerance to carbamates (1-4 \times) and mosaic susceptibility or resistance to neonicotinoids (0.7-24 \times) and avermectins (1-3 \times).
- A statistically significant delay in the expression of poisoning symptoms is found in all the studied populations upon contact male cockroach with the glass surface treated with 20 μ g a.i./cm² of cypermethrin, chlorpyrifos, propoxur, and fipronil. A delayed insecticidal effect on resistant cockroaches or complete insecticide ineffectiveness has been established.
- In this regard, it is necessary to determine the level of insect resistance and develop the individual insecticide rotation scheme for each location. Analysis of the data obtained makes it possible to assume that we are dealing with the multiresistance accompanied with different genetic mechanisms - the occurrence of *Kdr*- and *Rdl*-mutations, changes in the permeability of cuticle and in the activity of enzyme systems, etc.
- Moreover, delay in cockroach poisoning after feeding baits based on isoxazolines, substances of new chemical class, having never been used in Russia, apparently demonstrates an increasing activity of detoxifying enzymes, in particular monooxygenases.
- In our situation, we can recommend to introduce into IPM system a number of baits based on hydramethylnon, abamectin, and hydroprene. It is necessary to use boric acid-based liquid baits and agents with mechanical type of action.

Table 1. Resistance ratio of male German cockroaches of urban strains vs. susceptible laboratory strain S-NIID (topical bioassay)

Insecticide / Strain	Resistance ratio at LC ₅₀											
	M1	M2	M3	M4	M5	M6	M7	OBN	U1	U2	U3	U4
Chlorpyrifos	15.0	9.5	15.0	1.7	0.8	26.0	30.0	11.5	10.0	15.0	11.5	18.0
Propoxur	4.1	0.9	1.4	0.7	0.8	3.4	1.1	3.5	1.7	1.1	1.4	1.6
Cypermethrin	142	283	225	13,3	5.4	290	>833	>4000	133	125	167	375
Fipronil	12.7	18.3	28.5	1.6	2.5	40.0	20.0	54.0	19.3	23.3	20.0	24.7
Acetamiprid	1.0	2.6	2.2	1.6	0.9	4.0	1.2	2.6	4.8	4.0	4.0	6.8
Imidacloprid	1.5	3.5	1.3	1.5	0.8	12.7	6.0	5.6	12.7	23.6	16.4	18.2
Thiametoxam	2.9	1.3	0.7	1.2	1.2	3.9	4.1	4.8	2.9	2.0	2.7	4.3
Clothianidin	1.6	2.3	2.7	2.0	2.4	2.7	2.0	2.4	1.3	2.2	3.0	1.7

Note: RR <10 – tolerance, > 10 - resistance



Table 2. RR values comparison of speed poisoning male cockroaches after contact with the insecticide-treated glass surface

20 μ g a.i./cm ²	OBN	M1	M6	U1	U2
Cypermethrin	>700	1.8	6.9	3.5	4.7
Chlorpyrifos	2.3	1.7	1.1	2.2	1.0
Propoxur	2.7	2.2	2.0	1.3	1.7
Fipronil	2.9	1.9	2.5	2.7	3.0

Fig 1. Dynamics of male cockroaches poisoning (fipronil, 20 μ g / cm²).

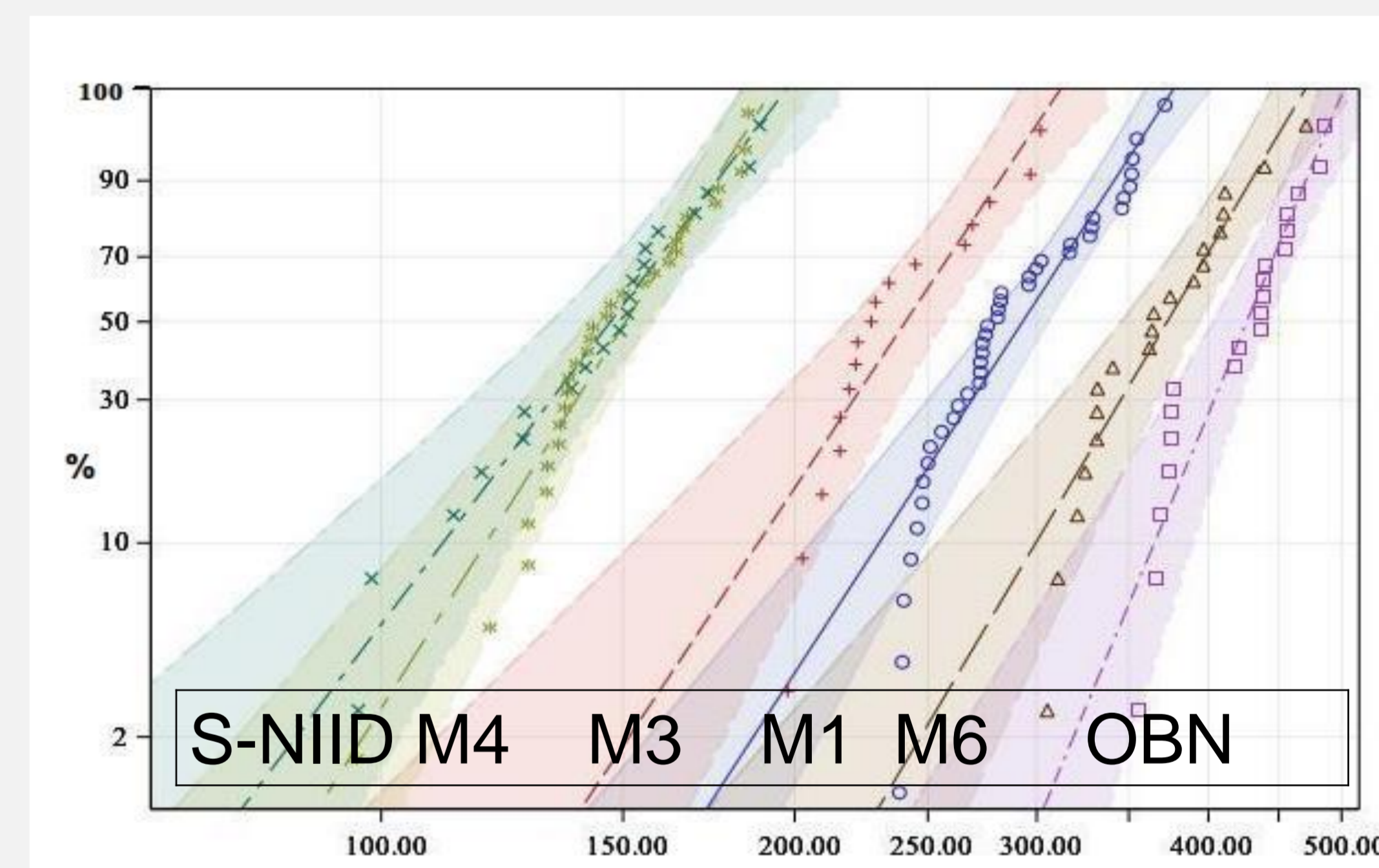


Table 3. Delayed mortality of cockroaches after feeding toxic baits

Insecticide	Conc %	Strain	RR at LT ₅₀	
			male	female
Propoxur	2.00	M1	2.5	ND
Chlorpyrifos	0.20	M1	ND	ND
Imidacloprid	2.15	M1	1.7	ND
Fipronil	0.05	M1	5.8	6.8
		M3	10.5	8.6
		OBN	4.1	9.5
Hydramethylnon	2.00	M1	1.2	0.5
Afoxolaner	0.05	OBN	4.0	4.7
Fluralaner	0.05	OBN	3.2	2.2
Spinosad	1.00	M1	3.0	2.8