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Insecticide Resistance in *Sitophilus zeamais* Mots. and *Rhizopertha dominica* (F.) in Indonesia

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ABSTRAK

Empat belas sampel Sitophilus zeamais *dan lima belas sampel* Rhizopertha dominica *yang diambil dari gudang BULOG dan gudang maga padi unit-unit koperatif desa di kebanyakan tempat di Indonesia telah diuji untuk kekebalan terhadap racun serangga malathion dan pirimifos metil. Dua sampel* S. zeamais *menunjukkan taraf kekebalan yang rendah terhadap malathion, sementara semua sampel peka terhadap pirimifos metil. Kekebalan* R. dominica *terhadap malathion hanya terdapat pada tiga sampel dari jumlah lima belas sampel yang diuji. Spesies yang utama dalam kumpulan* Sitophilus *ialah* S. zeamais.

ABSTRACT

Fourteen strains of Sitophilus zaemais *and fifteen strains of* Rhizopertha dominica, *collected from rice warehouses and farmers' storage facilities throughout Indonesia were tested for resistance to malathion and pirimiphos methyl. Two strains of* S. zeamais *showed a slightly resistant response to malathion, while all strains of this species were susceptible to pirimiphos methyl. Resistance of* R. dominica *to malathion was detected in three out of the fifteen strains tested. The predominant species of* Sitophilus *was* S. zeamais.

INTRODUCTION

Sitophilus zeamais and *Rhizopertha dominica* are important pests of stored grains. In Indonesia, *S. zeamais* has been reported to be the main primary pest of milled rice (Haines and Pranata, 1982) while *R. dominica* infests mainly rough rice (personal observation). Malathion resistance in *Sitophilus* spp. and *R. dominica* has been reported from several countries of the world (Parkin, 1965; Lemon, 1967; Morallo-Rejesus, 1974; Champ and Dyte, 1976; and Haliscak and Beeman, 1983).

Malathion has been widely used for many years as a protective treatment against these pests, although at the time of our study in 1979, it had been replaced by pirimiphos methyl for use in BULOG stores in Indonesia.

Until 1978, there had been no thorough studies of insecticide resistance in storage pests in Indonesia. Our study was undertaken in 1978 – 79 and the results relating to *Tribolium castaneum* have already been published (Osman and Morallo-Rejesus, 1981). In 1981, Pranata and Sunjaya tested some further samples from Indo-

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nesian stores for insecticide resistance, as reported by Pranata and Haines (1982) and Pranata *et al.*, (1983).

This paper reports the results of our study on the occurrence of resistance to malathion and pirimiphos methyl in *S. zeamais*, and to malathion in *R. dominica*, in Indonesia from 1978 – 1979. All samples of *Sitophilus* were carefully examined to determine which species were present.

MATERIALS AND METHODS

Test Insects

This study was conducted at BIOTROP, Bogor, Indonesia from 1978 – 1979. The insect specimens were collected from various places in Java following methods recommended by FAO (1974). Insect specimens from Sumatra, Kalimantan, Sulawesi, Irian Jaya and Nusa Tenggara Timur were provided by BULOG and its agencies through mail. General information about the various samples is presented in Tables 1 and 2. Fourteen strains of *S. zeamais* and fifteen of *R. dominica* were tested. Three replicates of 40 insects each were used in each test.

Resistance Test

The two insecticides used for resistance detection were malathion and pirimiphos methyl; both were emulsifiable concentrates of 57 and 25% a.i. respectively. The discriminating doses and exposure times for both the species studied are presented in Table 3. Aliquots of 0.5 ml of stock solution were evenly distributed on Whatman No. 1 filter papers of 7 cm diameter which were placed in petri dishes.

TABLE 1
Information on field-collected strains of *Sitophilus* spp. from various parts of Indonesia

Sample Number	Locations	Types of[1] Warehouse	Commodity	Insecticidal[2] history
1	Ranca Udik (Krawang)	New BULOG	milled rice	M, PM
2	Krawang	FS	padi	NCS
3	Bandung	New BULOG	milled rice	M, PM
4	Bogor	CRIA	corn	Unknown
5	Bogor	Commercial	green gram	Unknown
6	Magelang	FS	milled rice	NCS
7	Wonosari	FS	cassava	NCS
8	Sukaraja (Purwokerto)	FS	rice bran	NCS
9	Purwokerto	FS	corn	NCS
10	Lumajang	Commercial	rice bran	Unknown
11	Ujung Pandang	New BULOG	milled rice	M, PM
12	Irian Jaya	New BULOG	milled rice	M, PM
13	Nusa Tenggara Timur	New BULOG	milled rice	M, PM
14	Banjarmasin	New BULOG	milled rice	M, PM

1. FS = farmers' storage
   CRIA = Central Res. Inst. for Agric.
   BULOG = Badan Urusan Logistik (the National Grain Logistics Agency)
2. M = malathion
   PM = pirimiphos methyl
   NCS = no chemical sprayed

TABLE 2
Information on field-collected strains of *R. dominica* from various parts of Indonesia

Sample Number	Location	Types of[1] Warehouse	Commodity	Insecticidal[2] history
1	Krawang	Commercial	padi	M, PM
2	Krawang	Commercial	padi	M, PM
3	Krawang	Commercial	padi	Unknown
4	Krawang	New BULOG	padi	M, PM
5	Krawang	New BULOG	padi	M, PM
6	Subang	FS	padi	NCS
7	Indramayu	Commercial	padi	M
8	Indramayu	FS	padi	NCS
9	Cirebon	Commercial	padi	PM
10	Cirebon	FS	padi	PM
11	Pati	FS	padi	NCS
12	Pati	New BULOG	padi	PM
13	Wonosari	FS	cassava	NCS
14	South Surabaya	Commercial	padi	Unknown
15	Palembang	New BULOG	milled rice	Unknown

1. FS = farmers' storage
2. M = malathion
PM = pirimiphos methyl
NCS = no chemical sprayed

TABLE 3
Discriminating concentrations and exposure times for detecting resistance in *S. zeamais* and *R. dominica*

Insect species	*S. zeamais*		*R. dominica*	
Insecticide	Conc. (%)	Exposure time (hrs.)	Conc. (%)	Exposure time (hrs.)
Malathion[1]	1.5	6	2.5	24
Pirimiphos methyl[2]	0.6	12	—	—

[1]Recommended by FAO (1974)
[2]Virrey (1976)

The physical conditions under which the test was conducted and the categorization of the different degrees of resistance were the same as reported in the previous study (Osman and Morallo-Rejesus, 1981).

Determination of the Sitophilus *species*

The *Sitophilus* strains were identified using characters described by Halstead (1964) and Proctor (1971).

RESULTS AND DISCUSSION

Identity of Sitophilus *Strains and their Distribution*

The aedeagi of all 1400 male *Sitophilus* examined had two longitudinal impressions on the flattened upper surfaces, and the tips were pointed, thus identifying them as *S. zeamais*. The predominant species of *Sitophilus* present in our samples was therefore *S. zeamais*. This observation agrees with the findings of McFarlane in 1977 (reported by Atmosudirdjo, 1981) who, from the identity of 200 specimens collected from two places in Java, concluded that *S. zeamais* occurred on milled rice in Java more commonly than previously assumed. The data obtained in our study confirmed that *S. zeamais* is common and widespread in Indonesia, especially on milled rice. Further survey work (Haines and Pranata, 1982) has also confirmed that in Java, *S. zeamais* is dominant on milled rice and maize, but that small numbers of *S. oryzae* are sometimes present on these commodities. These authors also found that *S. oryzae* is often dominant on rough rice, however, and this has been shown (Husain *et al.*, 1983) to be explicable by the different rates of increase of the two species on the two forms of rice.

Resistance of S. zeamais *to Malathion and Pirimiphos Methyl*

Fourteen strains of *S. zeamais* were tested for resistance to both insecticides. Twelve strains were classified as susceptible to malathion and two showed a low degree of resistance (Table 4). All strains showed a susceptible response to pirimiphos methyl. From the interview conducted during the collection, it was found that where pirimiphos methyl was used, it had been first used sometime in May 1978. At the date of collection, pirimiphos methyl had only been used for five months to control these storage insects. Five months is probably too short for selection to occur with this insecticide.

TABLE 4
Response of *S. zeamais* to a discriminating concentration of 1.5% malathion for 6 hours.

Sample Number	Percent Knockdown	Degree of Resistance[1]
1	100	S
2	100	S
3	100	S
4	100	S
5	100	S
6	100	S
7	100	S
8	93.3	SR
9	100	S
10	100	S
11	100	S
12	100	S
13	100	S
14	93.3	SR

[1] S = susceptible
SR = slightly resistant

TABLE 5
Response of *R. dominica* to a discriminating concentration of 2.5% malathion for 24 hours.

Sample Number	Percent Knockdown	Degree of Resistance[1]
1	100	S
2	100	S
3	100	S
4	100	S
5	100	S
6	100	S
7	100	S
8	100	S
9	100	S
10	100	S
11	62.97	HR
12	84.23	MR
13	100	S
14	94.67	SR
15	100	S

[1]S = susceptible
SR = slightly resistant
MR = moderately resistant
HR = highly resistant

Resistance of R. dominica *to Malathion*

Fifteen strains of *R. dominica* were tested for resistance to malathion. The two strains from Pati (Central Java) were both resistant (one moderately and one highly) and one from South Surabaya (East Java) was slightly resistant; the other twelve strains were susceptible to malathion (Table 5). Strains of *R. dominica* were not tested with pirimiphos methyl because information on the discriminating concentration was not available.

General Pattern of Resistance

In a short follow-up to the present surveys in 1981, it was found that five samples of *R. dominica* and ten of *S. zeamais* were resistant to malathion (Pranata and Haines, 1982).

In our study, five strains of *R. dominica* were collected from stores that had indicated the use of malathion, but all these strains showed a susceptible response to this insecticide.

Of the seven strains collected from stores recording no history of malathion use, two strains were detected to be resistant and five were susceptible. One resistant and two susceptible strains were from stores whose insecticidal history was not available. Six strains of *S. zeamais* were from stores in which the use of malathion was recorded, and one of these strains was resistant to this insecticide. Of the five strains obtained from stores recording no insecticidal history, one strain was found to be resistant to malathion. Three susceptible strains of *S. zeamais* came from stores whose insecticidal history was not known. The occurrence of

resistance did not seem to be associated directly with the history of use of malathion in a particular store, presumably because populations of *S. zeamais* and *R. dominica,* being internal feeders in grain, are strongly associated with the movement of their batch of commodity from store to store; residual populations in unswept debris are obviously a potent source of resistant strains if insecticides are regularly used on the fabric of the store. But our results indicate that this was not happening in Indonesia at the time of our survey.

CONCLUSIONS

Two strains of *Sitophilus zeamais* showed a slight resistance to malathion. Twelve out of the fourteen strains showed a susceptible response to this insecticide. All the strains of *S. zeamais* were susceptible to pirimiphos methyl. Three out of the fifteen strains of *Rhizopertha dominica* collected showed some level of resistance to malathion.

The fourteen strains of *Sitophilus* collected from various parts of Indonesia were all found to be *S. zeamais.*

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