Safe Use of Pesticides in Rice-Fish Culture

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Introduction

Rice and fish are staple foods in Myanmar. Ricefields offer additional water areas for fry, fingerling and fish production. Farmers raise fish in ricefields for food and as a source of extra income. The fish harvested from ricefields are as important as the rice harvest in some regions for they give the farmer more income and the village community much needed protein, vitamin- and calcium-rich food. Fish cultured in ricefields may also increase rice production and help in pest control. However, when application of pesticides is still needed, these may harm the fish.

Ricefields are usually stocked with 5-10-cm fingerlings, two weeks after rice transplant. We therefore studied the tolerance of such fish to different pesticides to help the farmer maintain insect pest control efficiently and keep the ricefield environment safe for fish.

Materials and Methods

Bioassays were conducted according to the methods outlined by Nishiuchi (1974) and APHA (1976) with some modifications to suit our facilities and objectives. *Cyprinus carpio*, *Labeo rohita*, *Oreochromis mossambicus*, *Channa punctata*, *Clarias batrachus* and *Anabas testudineus* were selected as test fish, ranging from 7 to 10 cm in total length. *Clarias batrachus*, *Anabas testudineus*, *Oreochromis mossambicus* and *Labeo rohita* could not be used in some bioassay tests due to the unavailability of this desired uniform size.

Nine different pesticides were studied: Diazinon 40% EC, Diazinon 10 G, Elsan 50% EC, Sumithion 50% EC, Furadan 3 G, Padan 50% SP, Kitazin 48% EC, Kitazin 17% G and EPN 45% EC. Fourteen glass aquaria, each of 40-l capacity, were used in each experiment, including two for controls and two each for six different concentrations of pesticides. A series of close concentrations were selected as presented in Table 1. The values shown in column I were used first. Whenever additional tests were needed, the appropriate values from column II were applied.

Table 1. Guide to selection of experimental concentrations based on decilog intervals.*

No.	Concentration Column I	Concentration Column II	Log of concentration
1	10.0	-	1.0
2	-	7.9	0.90
3	6.3	-	0.80
4	-	5.0	0.70
5	4.0	-	0.70
6	-	3.2	0.50
7	2.5	-	0.40
8	-	2.0	0.30
9	1.6	-	0.20
10	-	1.25	0.10
11	1.0	-	0.00

*Adapted from APHA (1976).

For some tests, additional test aquaria were used to permit more than six concentrations. The concentrations of pesticides are expressed in parts per million (ppm) of the active ingredient (a.i.). After every bioassay test, the test aquaria were cleaned chemically to minimize residual contamination, as suggested by Lennon and Walker (1964).

The aquarium water had pH values of 7.0-7.8; dissolved oxygen, 7.2-8.0 ppm; CO_2, 1.8-2.4 ppm; total alkalinity, 32-45 ppm; total hardness, 38-47 ppm; and water temperature, 27-30°C. The numbers of fish surviving at 96 hours at every pesticide concentration were observed and recorded. The acute toxicity of the pesticide to these fish was estimated as the 96-hour "TLm" (Median Tolerance Limit), by the method of Litchfield and Wilcoxon (1949) with graphical interpolation (APHA 1976). Safety indexes for pesticide use and ranking of pesticide toxicity were determined using the method of Hashimoto (1970). A safety index is equivalent to the ratio of the expected maximum concentration of the pesticide in ricefield water to TLm. A smaller index means higher safety.

Commonly, the water depth in ricefields varies from 5 to 25 cm during the 3-5 months after transplantation which are suitable for fish culture. In order to investigate the potential toxicity of pesticides to fish in the ricefields during this period, we determined the safety index for each pesticide in conditions equivalent to ricefield water depths of 5, 15 and 25 cm.

Results and Discussion

On the assumption that sprays or granules are distributed evenly over the ricefields, the standard application roles for Elsan 50% EC, Furadan 3 G and EPN 45% EC would give initial concentrations of 1.90, 1.09 and 1.68 ppm, respectively, at a depth of 5 cm (Table 2). These concentrations exceed the 96-hour TLm values for some test fish. However, the initial concentrations of Diazinon 40% EC, Diazinon 10 G, Sumithion 50% EC, Padan 50% SP, Kitazin 48% EC and Kitazin 17% G show these to be safe for those test fish.

Based on these results, pesticides can be categorized for their relative safety for use in ricefield culture with the fish species listed here (Table 3).

The A-pesticides in Table 3 can be used without special precautions. The B-pesticides are less safe and considerable care must be taken if they are used on a large scale. Pesticides should never be applied at more than the recommended rates. The C-pesticides should not be used in ricefields stocked with these fish species.

The author, in previous research work on the residual toxicity of some insecticides to fish, found that Kitazin 48% EC, Elsan 50% EC, Padan 50% SP, EPN 45% EC, Diazinon 40% EC and Sumithion 50% EC were toxic to fish in ricefields after

Table 2. Application rates, expected initial concentrations and safety indexes of different pesticides for *Cyprinus carpio*, *Labeo rohita*, *Oreochromis mossambicus*, *Channa punctata*, *Clarias batrachus* and *Anabas testudineus* in ricefield waters at depths of 5, 15 and 25 cm.

No.	Pesticide %s refer to a.i.	Standard application rates per acre*	Expected maximum concentration (ppm of a.i.) in ricefield waters at depths of			Species	96-hour TLm ppm (a.i.)	Safety indexes of pesticides for fish in ricefield waters at depths of		
			5 cm	15 cm	25 cm			5 cm	15 cm	25 cm
1	Diazinon 40% EC	800 ml	1.52	0.50	0.30	*C. carpio*	3.4	0.45	0.15	0.08
						L. rohita	5.4	0.28	0.09	0.06
						O. mossambicus	1.3	1.17	0.38	0.23
						Ch. punctata	4.3	0.35	0.12	0.07
						Cl. batrachus	5.8	0.26	0.08	0.05
						A. testudineus	5.2	0.29	0.10	0.06
2	Diazinon 10 G	20 kg	2.42	0.81	0.48	*C. carpio*	3.8	0.64	0.21	0.13
						L. rohita	N.A.	N.A.	N.A.	N.A.
						O. mossambicus	N.A.	N.A.	N.A.	N.A.
						Ch. punctata	6.4	0.38	0.13	0.08
						Cl. batrachus	8.6	0.28	0.09	0.06
						A. testudineus	5.2	0.29	0.10	0.06
3	Elsan 50% EC	800 ml	1.90	0.63	0.38	*C. carpio*	1.50	1.27	0.42	0.25
						L. rohita	0.40	4.75	1.58	0.95
						O. mossambicus	0.01	271.43	90.00	54.30
						Ch. punctata	0.04	47.50	15.75	9.50
						Cl. batrachus	0.03	63.33	21.00	12.67
						A. testudineus	0.37	5.14	1.70	1.03
4	Sumithion 50% EC	800 ml	1.90	0.63	0.38	*C. carpio*	3.0	0.63	0.21	0.13
						L. rohita	3.5	0.54	0.18	0.11
						O. mossambicus	1.8	1.06	0.35	0.21
						Ch. punctata	4.5	0.42	0.14	0.08
						Cl. batrachus	N.A.	N.A.	N.A.	N.A.
						A. testudineus	N.A.	N.A.	N.A.	N.A.
5	Furadan 3 G	676 g	1.09	0.36	0.22	*C. carpio*	1.3	0.84	0.28	0.17
						L. rohita	0.7	1.56	0.51	0.31
						O. mossambicus	0.2	5.45	1.80	1.10
						Ch. punctata	0.4	2.73	0.90	0.55
						Cl. batrachus	N.A.	N.A.	N.A.	N.A.
						A. testudineus	N.A.	N.A.	N.A.	N.A.
6	Padan 50% SP	250 g	0.60	0.20	0.12	*C. carpio*	0.7	0.86	0.29	0.17
						L. rohita	0.3	2.00	0.67	0.40
						O. mossambicus	0.6	1.00	0.33	0.20
						Ch. punctata	1.6	0.38	0.13	0.08
						Cl. batrachus	N.A.	N.A.	N.A.	N.A.
						A. testudineus	N.A.	N.A.	N.A.	N.A.
7	Kitazin 48% EC	250 ml	0.60	0.20	0.12	*C. carpio*	4.5	0.13	0.04	0.02
						L. rohita	2.4	0.25	0.08	0.05
						O. mossambicus	1.6	0.38	0.13	0.08
						Ch. punctata	9.2	0.06	0.02	0.01
						Cl. batrachus	N.A.	N.A.	N.A.	N.A.
						A. testudineus	N.A.	N.A.	N.A.	N.A.
8	Kitazin 17 G	9 kg	2.56	0.85	0.51	*C. carpio*	15.0	0.17	0.06	0.03
						L. rohita	5.5	0.47	0.15	0.09
						O. mossambicus	3.0	0.85	0.28	0.17
						Ch. punctata	9.0	0.28	0.09	0.06
						Cl. batrachus	N.A.	N.A.	N.A.	N.A.
						A. testudineus	N.A.	N.A.	N.A.	N.A.
9	EPN 45% EC	800 ml	1.68	0.56	0.34	*C. carpio*	2.5	0.67	0.22	0.14
						L. rohita	0.4	4.20	1.40	0.85
						O. mossambicus	0.13	12.92	4.31	2.62
						Ch. punctata	2.0	0.84	0.28	0.17
						Cl. batrachus	N.A.	N.A0.	N..	N.A.
						A. testudineus	N.A.	N.A.	N.A.	N.A.

a.i = Active ingredient. N.A. = Data not available.
* Adapted from "Chemical control measures for various pests on crops", Myanmar Agriculture Service (1988).

Table 3. Relative safety of pesticides for various fish species used in rice-fish culture, for floodwater depths of 5, 15 and 25 cm after transplanting. A = relatively safe (safety index < 0.1); B = less safe, needing considerable care for large-scale use (safety index 0.1-5.0); C = unsafe for ricefield use (safety index >5.0). Where water fluctuations are unavoidable, the most toxic situation (5 cm depth) should be considered. The numbers assigned to pesticides are those given in Table 1. "None" means none of the pesticides tested fit this category.

Fish species	Pesticide category of safety A (relatively safe)	B (less safe)	C (unsafe)
Cyprinus carpio			
5 cm	None	1,2,3,4,5,6,7,8,9	None
15 cm	7,8	1,3,4,5,6,9	None
25 cm	1,7,8	2,3,4,5,6,9	None
Labeo rohita			
5 cm	None	1,3,4,5,6,7,8,9	None
15 cm	1,7	3,4,5,6,8,9	None
25 cm	1,7,8	3,4,5,6,9	None
Oreochromis mossambicus			
5 cm	None	1,4,6,7,8	3,5,9
15 cm	None	1,4,5,6,7,8,9	3
25 cm	7	1,4,5,6,8,9	3
Channa punctata			
5 cm	7	1,2,4,5,6,8,9	3
15 cm	7,8	1,2,4,5,6,9	3
25 cm	1,2,4 6,7,8	5,9	3
Clarias batrachus			
5 cm	None	1,2	3
15 cm	1,2	None	3
25 cm	1,2	None	3
Anabas testudineus			
5 cm	None	1,2	3
15 cm	1,2	3	None
25 cm	1,2	3	None

4-10 days (Kyaw Myint Oo 1991), and that repeated applications of these pesticides in ricefields could prolong the exposure period to fish and produce later mortalities. In such cases, fish refuges are needed during the application of pesticides. Water from the treated field is presented from flowing into the refuge, the size and depth of which depends on the scale of operations.

When C-ranked pesticides are used for pest control, it is important that before application of such pesticides the field is drained and fish confined to trenches and sumps. Extreme care should be taken so that pesticides do not contaminate trenches and sumps. In this manner, the harmful effects of pesticides to fish can be greatly reduced. The data from this research may assist the safe use of pesticides in other types of rice-fish culture.

References

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News Items

Third Asian Regional Rice-fish Farming Research and Development Workshop

THE THIRD ASIAN REGIONAL RICE-FISH FARMING RESEARCH AND DEVELOPMENT WORKSHOP was held at the Sukamandi Research Institute for Food Crops (SURIF), Subang, West Java, Indonesia, 6-11 June 1993. The workshop was sponsored jointly by the International Center for Living Aquatic Resources Management (ICLARM) and the Central Research Institute for Food Crops (CRIFC) of the Indonesian Agency for Agricultural Research and Development (AARD). Focusing on the role of fish in enhancing ricefield ecology and in Integrated Pest Management (IPM) as its theme, the workshop had the following specific objectives:

- to review the state of knowledge on the ecology of integrated rice-fish systems and the role of fish in IPM;
- to organize further study and to elaborate methodologies for ricefield ecology and IPM; and
- to draw up plans for further research on the role of fish in ricefield ecology and IPM.

The participants were from Bangladesh, Indonesia, Malaysia, the Philippines, Thailand, Vietnam, ICLARM, IDRC and IRRI. They included NGO staff active in rice-fish development; researchers and trainers involved in IPM and human disease vector control; and researchers involved in the nutrient dynamics of ricefields and the socioeconomic analysis of farmers' perceptions on rice-fish farming and its adoption.

The papers presented and the group discussions provided new information