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Original Article

Acute toxicity of two pesticides Diazinon and Deltamethrin on Tench (*Tinca tinca*) larvae and fingerling

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Abstract: Diazinon and deltamethrin are common useful agricultural pesticides in the world. The present research compared the acute toxicity of diazinon and deltamethrin to tench larvae and fingerling. LC_{50} of 24 h, 48-h, 72 h and 96 h were determined using a probit. Fish samples (21 fish in each test group) were exposed to different concentrations of diazinon and deltamethrin (diazinon: for fingerling between1-20 ppm and larvae 0.25-2 ppm, deltamethrin: for fingerling between 0.01-0.2 ppm and larvae 0.0025-0.02) for 96 h and mortality were recorded. The LC_{50} 96 h of diazinon for fingerlings and larvae were 6.77 and 0.63, respectively. The LC_{50} 96 h of deltamethrin for fingerlings and larvae were 0.07 and 0.005 ppm, respectively. According to the results, larvae are more sensitive than fingerlings, LC_{50} values indicated that deltamethrin is more toxic than diazinon to *Tinca tinca*, so we suggest to use diazinon instead of deltamethrin in agriculture.

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Introduction

Tench (*Tinca tinca*) is a freshwater and brackish water cyprinid. It normally inhabits slow-moving freshwater habitats, particularly lakes and lowland rivers (Whitton, 1982). Typically, this species lives in shallow, densely vegetated lakes and backwaters. It often overwinters in mud and spawns among dense vegetation in still water. *T. tinca* has economic and ornamental values.

Tench is distributed throughout the Europe for centuries and thus has blurred the original distribution pattern. Hypothesized to be native in most of Europe, naturally absent only in Ireland, Scandinavia north of 61°30' N, eastern Adriatic basin and western and southern Greece where it is now introduced. In Asia, native eastward to western Yenisei drainage south of 60° N. Introduced to North and South Africa, Tasmania, Australia, New Zealand, India, North America, Chile and probably elsewhere (IUCN, 2012).

The present study was performed to determine toxicity of diazinon and deltamethrin as potential dangerous organic pesticides to assess mortality effects of these chemicals to the tench, these tow pesticides are common to control herbal pests in many agriculture fields that are located in the vicinity of fresh water resources.

Deltamethrin is a synthetic pyrethroid insecticide and acaricide. It is used topically for the control of ectoparasites in cattle, sheep and poultry. It is also widely used as a pesticide on crops (EMEA, 2000). Diazinon is one of the most functional organophosphate known pesticides commonly enters through the agricultural fields drain into surface water and groundwater (Sohrabi et al., 2011). In recent studies of surface water, coastal and even

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wastewater treatment systems in urban areas in different parts of the world, including Iran, significant amounts of these toxins have been reported (Shayeghi et al., 2001; U.S. EPA, 2005).

Fish is one of the important aquatic organism because of the economic value and the sensitivity against contaminants, thus they are used in a wide range for biological assays (Ola, 1369). Today major threat of tench populations is river engineering (IUCN, 2012) and given that it is a potamodromous species (Riede, 2004), investigate the effects of agricultural pesticides on its life seems to be essential.

Materials and methods

Fishes and concentration treatments: This research aimed to determine the toxicity of diazinon and deltamethrin on *Tinca tinca* larvae and fingerlings. Lethal experiments were conducted using 125 larvae and 125 fingerling for each of the tested pesticides. Physicochemical properties of water were measured: temperature 23±1, pH 6/5-8, total hardness 220 mg/l and dissolved oxygen 7-9/5 mg/l. During the experiment, water was not exchanged. Before the test, fish were feed twice daily with Biomar with the amount of 2% of body weight.

Applied concentrations of diazinon were 1, 5, 10, and 20 for fingerlings and 0.25, 0.5, 1 and 2 mg/l for larvae. These concentrations for deltamethrin were 0.01, 0.05, 0.1 and 0.2 for fingerling and 0.0025, 0.005, 0.01 and 0.02. For each experiment, fingerlings and larvae were divided into four groups i.e. there were four group including fingerlings exposed to diazinon, larvae exposed to diazinon, fingerling exposed to deltamethrin and larvae exposed to deltamethrin. In each group, there were four treatments and one control. Mortality rates were recorded at 0, 24, 48, 72 and 96 h.

Statistical analysis: Experiments were performed according to the O.E.C.D standard method (1998), to find the LC_{50} 96 h of tench larvae and fingerlings. The numbers of dead fish were recorded at 24, 48, 72, 96 h. Acute toxicity tests was carried out according to Hotos and Vlahos (Gooley et al., 2000). The nominal concentration of diazinon and deltamethrin estimated to result in 50% mortality of *Tinca tinca* within 24 h (24 h LC_{50}), 48 h, 72 h and 96 h was attained by probit analysis by software SPSS Version 16.

Results

During the study number of dead larvae and fingerlings for deltamethrin and diazonin doses were examined depending on duration (24, 48, 72 and 96 h) of exposure in tench larvae and fingerlings. With increasing deltamethrin concentrations, both larvae and fingerling exposed duration 24-96 h had significantly increased number of dead fish.

The highest diazinon and deltamethrin concentration showed the highest larvae and fingerling mortality (Tables 1 and 2).

No fish died during the acclimation period before exposure, no control fish also died during acute toxicity tests. Median lethal concentrations of 10%, 30%, 50%, 70%, 90% and 99% test are presented in Tables 3 and 4. The results of this study indicated

Table 1. The mortality rate of *Tinca tinca* exposed to acute commercial Diazinon (21 fish for each concentration).

Group	Concentration (ppm)	No. of dead fish			
		24h	48h	72h	96h
Fingerling	1	0	1	2	5
	5	0	1	3	9
	10	1	3	8	14
	20	3	7	14	21
	Control	0	0	0	0
Larvae	0.25	0	1	2	8
	0.5	1	3	6	10
	1	2	4	9	14
	2	3	7	14	21
	Control	0	0	0	0

Table 2. The mortality rate of *Tinca tinca* exposed to acute commercial Deltamethrin (21 fish for each concentration).

Group	Concentration(ppm)	No. of dead fish			
		24h	48h	72h	96h
Fingerling	0.01	0	0	1	4
	0.05	0	2	5	8
	0.1	1	4	8	14
	0.2	2	7	13	21
	Control	0	0	0	0
Larvae	0.0025	0	1	3	6
	0.005	0	3	7	11
	0.01	2	6	11	16
	0.02	4	11	17	21
	Control	0	0	0	0

Table 3. Lethal Concentrations of Diazinon.

Group	Point	Concentration (ppm)			
		24 h	48 h	72 h	96 h
Fingerling	LC_1	6.24	-	-	-
	LC_{10}	17.2	8.88	2.93	-
	LC_{30}	25.14	18.34	9.99	3.99
	LC_{50}	30.64	24.9	14.88	6.77
	LC_{70}	36.13	31.46	19.77	9.56
	LC_{90}	44.07	40.92	26.83	13.58
	LC_{99}	55.03	53.98	36.57	19.12
Larvae	LC_1	-	-	-	-
	LC_{10}	1.48	0.62	0.12	-
	LC_{30}	2.68	1.72	0.87	0.35
	LC_{50}	3.51	2.47	1.39	0.63
	LC_{70}	4.33	3.23	1.91	0.91
	LC_{90}	5.53	4.32	2.65	1.31
	LC_{99}	7.18	5.83	3.68	1.87

LC_{50} 96 h of diazinon was 6.77 ppm for fingerling and 0.63 ppm for larvae. Thus MAC value was equal to 0.677 and 0.063 ppm, respectively (Table 3). For deltamethrin, MAC value for fingerling and larvae were 0.007 and 0.0005 for fingerlings and larvae, respectively (Table 4).

Discussion

Contamination of aquatic environment with pesticides via rainfall runoff is very common (Willis and McDowell, 1982). The toxicity of deltamethrin and diazinon on tench increased with increasing concentration and exposure time. Previous studies indicated the high toxicity of deltamethrin to fish species, which is in agreement with our results (Boateng et al., 2006).

It has been shown that a low level of deltamethrin (0.005 µg/l) in the aquatic environment may have a significant effect on carp populations. As toxicant for aquatic life, it should be used with great attention in agriculture to protect natural waters (Köprücü and Aydın, 2004). Although synthetic pyrethroids are less persistent and less toxic to mammals and birds (Sayeed et al., 2003), they are highly toxic to a number of non-target organisms such as bees, freshwater fishes and other aquatic organisms even at very low concentrations (Oudou et al., 2004). For this reason, these organisms are extremely sensitive to neurotoxic effects of pyrethroids when they reach surface water-courses (Bradbury and Coats 1989, Haya, 1989; Mittal et al., 1994).

Deltamethrin alters the hepatic metabolism and the normal ionic flux in some species; Bálint et al. (1995) observed 20% decreases in acetyl cholinesterase activity of the brain, heart, blood, liver and skeletal muscle of carp after a three-day exposure to deltamethrin. (Cristina da Silva de Assis et al., 2009)

Table 4. Lethal Concentrations of Deltamethrin.

Group	Point	Concentration (ppm) 24 h	48 h	72 h	96 h
Fingerling	LC_1	0.04	-	-	-
	LC_{10}	0.2	0.08	0.02	0.006
	LC_{30}	0.31	0.17	0.1	0.04
	LC_{50}	0.39	0.23	0.15	0.07
	LC_{70}	0.47	0.29	0.2	0.09
	LC_{90}	0.58	0.38	0.28	0.13
	LC_{99}	0.74	0.51	0.38	0.18
Larvae	LC_1	0.005	-	-	-
	LC_{10}	0.015	-	0.0007	0.0003
	LC_{30}	0.023	0.08	0.006	0.003
	LC_{50}	0.028	0.18	0.011	0.005
	LC_{70}	0.033	0.29	0.015	0.008
	LC_{90}	0.041	0.44	0.021	0.011
	LC_{99}	0.051	0.65	0.029	0.015

Diazinon is a very highly toxic organophosphate compound. Organophosphates are long known and widely applied active ingredients of different insecticides. In the living organism, organophosphates inhibit the enzyme acetyl cholinesterase, accumulate acetylcholine, a neurotransmitter involved in impulse transmission, and lead to an over-stimulation of the parasympathetic nerves (Farage-Elawar, 1989). Poisoned animals show salivation, lachrymation, diarrhea and convulsions followed by depression, prostration, ataxia and cyanosis, and then death usually within a short time (Brown et al., 2003).

The results of researches on carp and other fish indicate diazinon causes anemia, reduction blood factors and weakening of the immune system of fish (Shamooshaki et al., 1390) and the results of this study agree with many studies on different fish species of Cyprinidae family such as effect of diazinon on *Rutilus frisii kutum*, *Abramis brama*, *Hypophthalmichthys molitrix* (Nasri Tajan, 1997), *Ctenopharyngodon idella* (Pourgholam et al., 2001), *Cyprinus carpio* embryos and larvae (Rahmi and Kenan, 2005), *Pimephales promelas* (Sibel et al., 2006) and deltamethrin on *Cyprinus carpio* (Mestres and Mestres, 1992). Our finding indicate that deltamethrin is more toxic than diazinon to this species and larvae are more sensitive than fingerlings, so we suggest to use diazinon instead of deltamethrin in agricultural applications.

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