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Research Article

Effects of Sumithion 50 EC on the growth and breeding performances of *Heteropneustes fossilis*

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ABSTRACT

The work was carried out to evaluate the toxic effects of Sumithion on growth and breeding performance of *Heteropneustes fossilis* as a model organism under three experiments in the Mini Hatchery cum Breeding Complex, Bangladesh Agricultural University, Mymensingh from August 2015 to June 2016. In this study, four doses of Sumithion such as 8.0, 10.0, 12.0, 14.0 ppm were used and larvae produced only from 8.0 ppm which was further reared. A number of 100 fry of 35 days old from control and treated group were separately reared in two ponds of 2 decimal in sizes. The average final lengths for control group (25.84±0.27 cm) was significantly higher ($p < 0.05$) than treated group (21.82±0.25 cm) and the average final weights for control group (34.78±0.17 g) was significantly higher ($p < 0.05$) than treated group (25.3±0.38 g). The percent length gain value of treated group (959.22±29.46%) was significantly higher ($p < 0.05$) than control group (549.25±12.65%). The percent weight gain value of control group (1319.59±14.83%) was significantly higher ($p < 0.05$) than treated group (1029.46±26.85%). A breeding trial of *H. fossilis* was given with both Sumithion treated and untreated fish. The 35 days old fry obtained from 8.0 ppm Sumithion concentration could not attain complete maturity after nine months of rearing as none of them ovulated. On the contrary, 100% of control fish ovulated and 82.33% fertilization and 80.33% hatching were obtained. The ovulation was partially, fertilization (62.29%) and hatching rates (60.89%) of Sumithion treated fish were lower than the Sumithion untreated fish. The results of the above experiments suggested that Sumithion at the concentration of 8.0 ppm has adverse effect on growth and breeding performance of *H. fossilis*.

INTRODUCTION

Aquaculture is a major component of agriculture in Bangladesh. However today, aquatic systems all over the country face serious threats from anthropogenic contaminants and contamination of water by pesticides, either directly or indirectly. Water contamination caused by pesticides can lead to fish kills, reduced fish productivity, or elevated concentrations of undesirable chemicals in edible fish tissue which can affect the health of humans consuming these fishes. Due to the residual effects of pesticides, important organs like gonad, kidney, liver, gill, stomach, brain and muscle are damaged.

The impact of pesticidal residues of agriculture and industries on the fisheries sector is presently a burning issue at local, national and global level. Pesticides have been considered as a major threat of gradual degradation for the aquatic ecosystem (Salam *et al.*, 2014). The use of pesticides is increasing day by day as associated with High Yielding Varieties (HYVs) cultivation. Every year about 7000 MT of pesticides are being used on agricultural fields (Lipi, 2008). Pesticides at high concentrations are known to reduce the survival, growth and reproduction of fish (Mckim *et al.*, 1975) and produce many visible effects on fish (Johnson and Julin, 1968).

Fishes are particularly sensitive to the water contamination. Pesticides have been found to damage significantly certain physiological and biological process when they enter into the organs of fishes (John, 2007; Banaee *et al.*, 2011). Pesticides decrease the fecundity and causes testicular and ovarian tissue damages (Dutta and Meijer, 2003; Banaee *et al.*, 2009). Tissue injuries and damages in organs may result in the reduced survival, growth and fitness, the low reproductive success or increase of susceptibility to pathological agents (Banaee *et al*., 2013). Sumithion is considered somewhat toxic to fish (Thomson, 1989). Sumithion 50 EC (O, O Dimethyl O-[3-methyl-4-nitrophenyl]) commonly known as Fenitrothion as its active compound is an organophosphate pesticide that has been in use since 1959. Sumithion that reach into aquatic habitats may influence various physiological processes that may impact upon the potential of fishes. However, Sumithion has such adverse effects on invertebrates and fishes; very limited work has been done on the effects of Sumithion on growth and breeding performance of fishes.

The Asian stinging catfish, *H. fossilis* (Bloch), is a species of airsac catfish. It is locally known as shingi. This species breeds in confined waters during the monsoon months, but can breed in ponds, derelict ponds, and ditches when sufficient rain water accumulates. However in recent years, the fish has become gradually endangered as their eggs, embryos and larvae are often exposed to the toxicity of pesticides when agricultural runoff enters into natural waterbody from agricultural field. On the other hand, the fish has become gradually been endangered as the natu-ral habitats and breeding grounds of this fish has been severely degraded due to over exploitation, ecological changes, reduction of water bodies, application of pesticides in rice cultivation, release of chemical effluents from industrial plants and hydrological changes due to construction of flood control infrastructure (Ali *et al*., 2018) The above were fulfilled through to observe the growth rate of *H. fossilis* up to maturity stage produced from untreated and Sumithion treated eggs and to compare the breeding performance between the *H. fossilis* broods produced from untreated and Sumithion treated eggs.

MATERIALS AND METHODS

The experiment was conducted in the Mini Hatchery cum Breeding Complex under the Department of Fisheries Biology and Genetics of the Faculty of Fisheries, Bangladesh Agricultural University, Mymensingh during the period of August 2015 to June 2016.

H. fossilis was collected from Kella beel, Mymensingh without any injury and reared in the cisterns with quality premium, crumble-2 feed, and appropriate management until they were used for experimentation. Sumithion 50 EC (50% Fenitrothion), the product of Sumitomo Chemical Company Limited (Japan), was applied in this experiment.

To produce experimental fish, healthy and sexually mature 10 male and 10 female brood fish were selected for breeding purpose to study the effect of Sumithion. Both males and females were treated with carp PG extract at the dose of 70 mg/kg body weight. Then the injected broods were kept in a hapa set in a cistern provided with continuous water flow. After 12 h of injection, females and males released eggs and sperm impulsively. Fertilized eggs of *H. fossilis* were incubated in small bowls with an effective water holding capacity of 500 ml each. The exposed concentrations were 8, 10, 12 and 14 ppm of Sumithion for incubation against a control. Each of the bowls was stocked with about 100 eggs in 4 treatments each having three replications. Aeration was provided in all the bowls. Survival and hatching rates were recorded during the rearing in the bowls. The five days old larvae produced from control and 8 ppm Sumithion treatment were reared for 30 days in two separate cisterns. Fry of doses10ppm and 12 ppm Sumithion were not reared as their health condition was not good. Chopped tubificid worms were fed ad-libitum**.** One hundred fry of 35 days old were stocked in two separate earthen ponds each of 2 decimal in size. Fish were fed with Quality premium feed (crumble-2) at 5% body weight. Growth data in terms of length (cm) and weight (g) were recorded upto 9 months from October 2015 to June 2016.

For comparing the breeding performance of *H. fossilis* broods produced from Sumithion treated and untreated eggs, healthy and sexually mature 6 male and 6 female brood fish were selected for breeding purpose from both treated and untreated groups. Both males and females were treated with carp PG extract at the dose of 70 mg/kg body weight. After administration of PG, 3 males and 3 females of Sumithion-treated broods were kept in a hapa set in a cistern and provided with continuous water flow through porous PVC pipe while the untreated 3 pairs were kept in a separate hapa under same management facilities. After 12 h of injection with PG the fishes were spawned impulsively.

RESULTS AND DISCUSSION

Effects of Sumithion on survival and hatching of fertilized eggs of H. fossilis

Four doses of Sumithion i.e. 8, 10, 12, 14 ppm against an untreated group were used. In untreated group the survival rate of eggs was 81.4%. Dose response in the form of survival rate of eggs was recorded as 81.3%, 63.4%, 54.3%, and 47.0%, respectively. Statistical analysis showed that survival rates of eggs in concentration 10, 12 and 14 ppm were significantly lower ($p<0.05$) than those of untreated (control) and 8 ppm. The survival rate of eggs decreased with increasing Sumithion concentration from 8 to 14 ppm (Fig. 1).

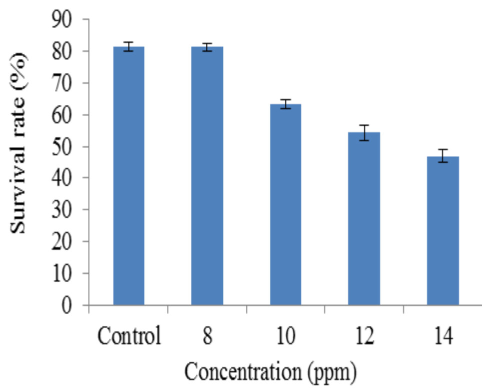

Fig.1. Survival rate (%) of *H. fossilis* eggs in different Sumithion concentrations (Vertical bars ±SD)

The hatching success of eggs with increasing concentrations of Sumithion doses of 8, 10, 12, and 14 ppm lead to a hatching rate of 78.8%, 61.3%, 51.9%, and 45.5%, respectively and hatching rate of untreated group was 79.4%. Among the four concentrations of Sumithion, hatching success in 8 ppm was significantly higher ($p<0.05$) than those of 10, 12, and 14 ppm. The hatching success of eggs decreased with the increasing Sumithion concentration from 8 to 14 ppm (Fig. 2).

Marimuthu *et al*., (2013) reported that mortality of eggs of African catfish, *C. gareipinus*, increased significantly with increasing Buprofezin concentrations from 5 to 100 mg/L. They also reported that increasing Buprofezin concentrations had significant effects on hatching success of eggs. According to them the hatching success of eggs with an increasing concentrations of Buprofezin i.e. 0.0, 0.05, 0.5, 5, 25, 50 and 100 mg/L lead to the hatching rate of 68.8, 68.9, 66.9, 66.4, 26.9, 25.1 and 0.12%, respectively ($p<0.05$).

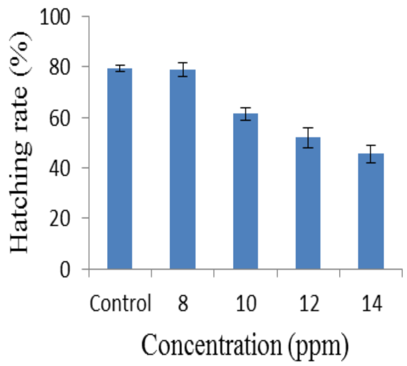

Fig.2. Hatching rate (%) of *H. fossilis* eggs in different Sumithion concentrations. (Vertical bars ±SD)

In higher concentration of Buprofezin the eggs took longer time to hatch. Aydin and Koprucu (2005) observed the number of dead embryos to increase significantly in response to Diazinon concentrations of 0.25, 0.5, 1.0, 2.0, 4.0 and 8.0 ppm. Takimoto *et al.*, (1984) also reported that exposure time of *Oryzias latipes* embryos to increasing concentrations of the organophosphate Fenitrothion (Sumithion) resulted in significantly different degrees of mortality and hatching success. They noticed that the embryo exposed to Fenitrothion at and above 5.0 ppm for the whole period of embryo (8 days) or a shorter period of exposure (3 days) showed some adverse effects on development of circulatory organs, hatchability and survival of the fry. The present results strongly support the earlier findings by Marimuthu *et al.* (2013), Aydin and Koprucu (2005) and Takimoto *et al*. (1984).

Growth performance of H. fossilis produced from Sumithion treated and untreated eggs when reared in ponds

After 30 days of rearing of 5 days old larvae before starting the long term rearing experiment there was an indication that Sumithion treated fish had inferior growth rate. Similar trend was maintained throughout the 9 months rearing period from October 2015 to June 2016. The average lengths in the beginning of experiment (October 2015) were 3.98±0.39 cm and 2.06±0.61 cm for control and Sumithion treated fish while average lengths at maturity after 9 months (June-2016) were 25.85±0.27 cm and 21.82±0.25 cm, respectively. The average lengths during November 2015 to May 2016 (month wise) were 5.36±0.64, 7.22±0.54, 9.34±0.37, 12.9±0.22, 15.5±0.18, 18.7±0.31, 21.34±0.32 cm, for the control group on the other hand, 4.19±0.47, 6.26±0.33, 8.36±0.34, 10.78±0.22, 12.9±0.27, 14.2±0.26 and 17.35±0.20 cm for Sumithion treated group. According to Independent-samples T test, length of control fish was significantly higher ($p<0.05$) than that of Sumithion treated ones. Month-wise average length of fish is shown in Fig. 3.

The average weight in the beginning of experiment was 2.45±0.51 g and 2.24±0.39 g for control and Sumithion treated fish while average weights at maturity after 9 months were 34.78±0.17 g and 25.30±0.38 g, respectively. The average weights during November, 2015 to May 2016 (month wise) were 5.20±0.77, 8.02±0.61, 12.20±1.69, 15.9±0.90, 20.2±0.59, 25.0±0.54 and 29.4±0.16g, found in the control group where as 4.12±0.36, 6.9±0.59, 9.3±0.17, 12.26±0.70, 14.90±0.19, 17.25±0.42 and 20.10±0.18 g found in Sumithion treated group. Month-wise average weight of fish is shown in Fig. 4. According to Independent-samples T test, weight of control fish was significantly higher ($p<0.05$) than that of Sumithion treated ones.

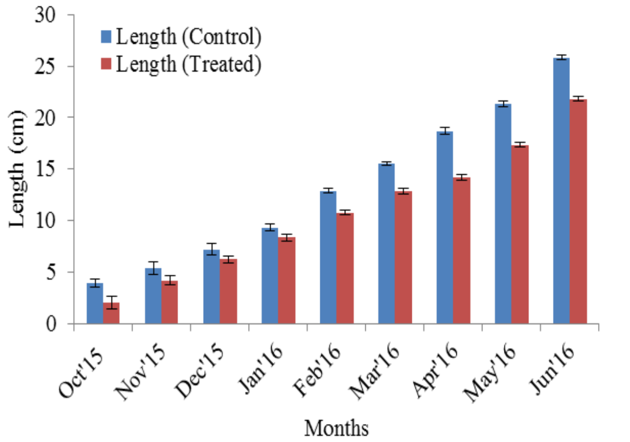

Fig.3. Month-wise average length of *H. fossilis* during the study period. (Vertical bars ±SD)

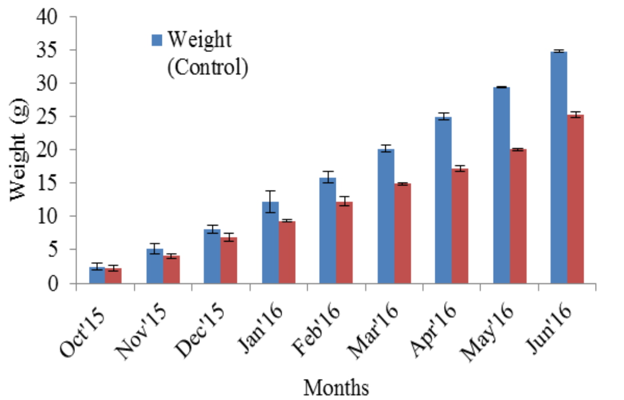

Fig.4. Month-wise average weight of *H. fossilis* during the study period. (Vertical bars ±SD)

The percent length gains of the fish of control and treated were 549.25±12.65% and 959.22±29.46%, respectively and percent weight gains were 1319.59±14.83% and 1029.46±26.85%, respectively. Lowest percent length gain was found in control group and highest percent length gain was found in treated group. According to Independent-samples T test, percent length gain value of treated group was significantly higher ($p > 0.05$) than control group. Highest percent weight gain was found in control group and lowest percent weight gain was found in treated group. However according to Independent-samples T test, the average value of percent weight gain of treated group was not significantly ($p>0.05$) less than control group. Though the percent length gain was increasing in the treated group but the percent weight gain was not increasing at the same rate in the treated group.

Percent length gain and percent weight gain are demonstrated in Fig. 5 and 6, respectively.

The final Specific Growth Rates (SGR%/day) of *H. fossilis* in control and treated groups were 0.98±0.08% and 0.90±0.06%, respectively (Fig. 7). According to Independent-samples T test; the difference of growth between control and treated groups was not significant.

The value of health condition of *H. fossilis* in control and treated groups were 1.35±0.02 g/cm and 1.16±0.01 g/cm, respectively **(**Fig. 8). According to Independent-samples T test, the average value of health condition in control group was significantly higher (p<0.05) than treated group.

Machova *et al*., (2010) reported that Diazinon 60 EC, organophosphate insecticide, had a direct impact on growth rate and mortality of larvae of tench, *Tincatinca* (L.). They conducted an experiment in which the exposure of fish to 0, 10, 100, 1,000, and 3,000 μg/dm^3 of Diazinon 60 EC was initiated 24 h after fertilization of eggs and continued for 32 days. At the highest concentration (3,000 μg/dm^3), total mortality of larvae was observed within the first 15 days of exposure. They cited that a concentration of 1000 μg/dm^3 highly decreased the growth rate of larvae while the concentration at the rate of 100 μg/dm^3 mildly decreased growth rate, but at concentration of 10 μg/dm^3 no changes compared to the control were observed. So the findings about the effects of pesticides on larval growth are more or less similar to the present findings though the doses and pesticides are different.

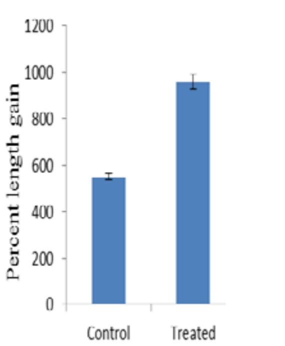

Fig.5. Comparison of percent length gain of *H. fossilis*

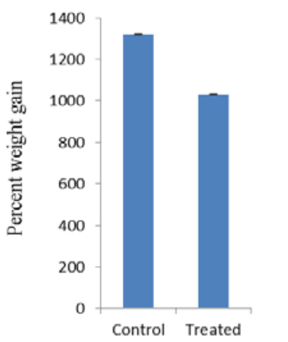

Fig.6. Comparison of percent weight gain of *H. fossilis*

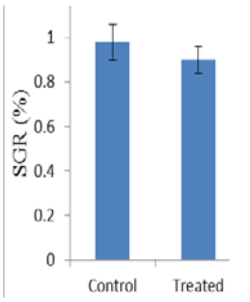

Fig.7. Comparison of Specific Growth Rate of *H. fossilis*

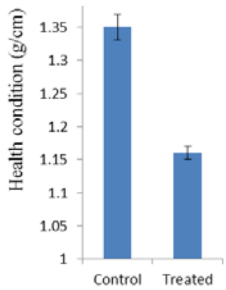

Fig.8. Comparison of health condition of *H. fossilis*

The effects of Sumithion on breeding performance of H. fossilis

A wide difference was found in ovulation rate between untreated and Sumithion treated fish. For untreated group, ovulation rate of female was 100%. On the other hand, the female in treated group ovulated partially. The fertilization and hatching rates of untreated and treated fish were 82.33% and 62.33% and 80.33% and 60.89%, respectively (Table 1). Statistical analysis showed that ovulation, fertilization and hatching rates of Sumithion treated fish were significantly (P<0.05) lower than the untreated fish.

Table 1. Breeding performance of Sumithion treated and untreated *H. fossilis*

Treatm-ent	PG dose (mg/ kg bwt)	Wt. of Female (g)	Ovulation of female (%)	Fertilization (%) (Mean ± SD)	Hatching (%) (Mean ± SD)
Untreat-ed	70	38	100	82.33± 2.08[a]	80.33± 2.0[a]
		33			
		28			
Sumithi-on treated	70	26	Partially	62.33± 3.07[b]	60.89± 1.86[b]
		21			
		18			

Fig.s in the same column having different superscripts are differed significantly (p > 0.05).

Adhikari *et al*. (2006) reported that cypermethrin, a synthetic pyrethroid, had significant effect on fertilization and hatching success of eggs of *L. rohita*. They conducted breeding trials of *L. rohita* with three sub-lethal concentrations of cypermethrin i.e. 0.16, 0.40 and 0.80 µl/L which resulted in reduced fertilization and hatching rate of eggs of *L. rohita* compared to control. They also found that exposure of *L. rohita* to three sub-lethal concentrations (0.06, 0.15 and 0.30 mg/L) of carbofuran, a carbamate pesticide, resulted in significant reduction of fertilization and hatching success compared to control. The findings on the effects of pesticide on fertilization and hatching rates of fish coincide with the present findings but it should be mentioned that *H. fossilis* and *L. rohita* are two different species and susceptibility towards different pesticides varies from species to species.

Finally it can be said that, nine months long pond trial proved the superiority of growth by the fish produced from untreated eggs compared to the Sumithion treated ones. A spectacular difference was observed in breeding performances between the females of treated and untreated groups. Under the same breeding protocol 100% female of untreated group ovulated and subsequently high percentage of fertilization and hatching occured while 100% of the female from Sumithion treated group failed to ovulate.

CONCLUSION

In conclusion it can be said that the present findings regarding toxic effects of Sumithion on *H. fossilis* greatly influences the growth, survival and hatchings of eggs. When the concentration of Sumithion was increased from 8.0 to 14.0 ppm then decreased the growth, survival and hatching of eggs. Long term exposure of organisms to pesticides causes a continuous health hazard for the population. Sumithion also adversely affected the breeding performance of *H. fossilis*. Even none of the Sumithion treated fish were ovulated.

REFERENCES

Adhikari, S., Sarkar, B., Chattopadhyay, A., Chattopadhyay, D.N., Sarkar, S.K., Ayyappan, S.A. 2006: Effect of Cypermethrin on breeding performances of a freahwater fish, *Labeo rohita* (Hamilton). *Chem. and Eco.*, 22 211-218.

Ali, A., Rahman, M. R., Alam, M.J., Nishat, A.A., Rabbi, M.F., Haque, M.A., Islam, R., Azam, M.R, Ullah, M.A. 2018. Production of Stinging Catfish (*Heteropneustes fossilis*) in different stock-ing densities with GIFT (*Oreochromis niloticus*) and Thai Sharpunti (*Bar-bonymus gonionotus*) in ponds. Journal of Fisheries and Life Sciences, 3(1); 9-15

Aydin, R., Koprucu, K. 2005: Acute toxicity of Diazinon on the common carp *(C. carpio L)* embryos and larvae. *Pest. Biochem. and Phy.*, 82 220-225.

Banaee, M., Mirvaghefi, A.R., Ahmadi, K., Ashori, R. 2009: The effect of Diazinon on histophatological changes of testes and ovaries of common carp (*Cyprinus carpio*). *Sci. J. Mar. Bio.*, 1 25-35.

Banaee, M., Sureda, A., Mirvagefei, A.R., Ahmadi, K. 2013: Histopathological alterations induced by Diazinon in rainbow trout (*Oncorhynchus mykiss*). *Int. J. Environ. Res.*, 735-744.

Banaee, M., Sureda, A., Mirvaghefi, A.R., Ahmadi, K. 2011: Effects of Diazinon on biochemical parameters of blood in rainbow trout (*Oncorhynchusmykiss*). *Pest. Biochem. and Phy.*, 99 1–6.

Dutta, H.M., Meijer, H.J.M. 2003: Sub-lethal effects of Diazinon on the structure of the testes of bluegill, *Lepomis macrochirus*: a microscopic analysis. *Environ. Pol.*, 125 355-360.

John, P.J. 2007: Alteration of certain blood parameters of freshwater teleost, *Mystus vittatus* after chronic exposure to Metasystox and Sevin. *Fish Phy. Biochem.*, 33 15-20.

Johnson, W.W., Julin, A.M. 1968: Acute Toxaphore to fathead minnows, channel catfish and bluegills, EPA-600/3-80-005, US Environmental Protection Agency Duluth Minn.

Lipi, R.B. 2008: Diazinon induced developmental deformities of stinging catfish *Heteropneustes fossilis*, MS thesis, Department of Fisheries Biology and Genetics, Bangladesh Agricultural University, Bangladesh.

Machova, J., Prokes, M., Penaz, M., Barus, V., Leuropova, H. 2010: Toxicity of Diazinon 60 EC for embryos and larvae of tench, *Tincatinca* (L). *Rev. in Fish Biol. and Fish.*, 20 409-415.

Marimuthu, K., Muthu, N., Xavier, R., Arockiaraj, J., Rahman, M.A., Subramanian, S. 2013: Toxicity of Buprofezin on the survival of embryo and larvae of African catfish, *Clarias gareipinus* . *Plo. On.* 8 3-14.

Mckim, J.M., Bemoit, D.A., Biesinger, K.K., Brungs, W.A., Siefert, R.E. 1975: Effects of pollution on freshwater fish. *J. Wat. Pol. con. Fed.*, 47 1711-1764.

Salam, M.A., Sharmin, S., Haque, F., Shahjahan, M. 2014: Acute toxicity of Sumithion and its effects on liver morphology in common carp, *Cyprinus carpio*. *In:* Proceedings of 5th International Conference on Environmental Aspects of Bangladesh. pp. 97.

Takimoto, Y., Hagino, S., Yamada, H., Miyamoto, J. 1984: The acute toxicity of Fenitrothion to killifish (*Oryziaslatipes*) at twelve different stage of its life history. *J. Pest. Sci.*, 9 463-470.

Thomson, W.T. 1989: Agricultural Chemicals. Book I: Insecticides. Thomson Publications, Fresno, CA. pp. 120.