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Acute toxicity of some agriculture fertilizers to fingerlings of *Catla catla*

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Abstract

Nitrogen fertilizers tend to increase ammonium concentration especially in the aquatic medium. To evaluate its impact, the acute toxicity of ammonium sulphate, urea and a composite fertilizer (15:15:15) (NPK-1) was assessed in fingerlings of fresh water fish *Catla catla* using a static test system. The toxicity of ammonium sulphate, urea and NPK1 to *C. catla* increased with increasing fertilizer concentration and duration of exposure. The concentration that killed 10% (LC_{10}) and 90% (LC_{90}) of fish varied with the fertilizers. The concentrations of ammonium sulphate, urea and NPK-1 that killed 50% of fingerlings of *C. catla* within 96-h (96-h LC_{50}) were 0.12, 0.19 and 0.18 g/L, respectively. Ammonium sulphate concentrations killing 50% (LC_{50}) of the fingerlings of fresh water fish *Catla catla*were 0.23, 0.17, and 0.14, 0.12 g/L during 24hr, 48hr, 72hr and 96hr correspondingly. Ammonium sulphate was found to be more toxic to the juvenile fresh water fish *C. catla* compared to urea and NPK-1.

Keywords: Acute toxicity, nitrogen fertilizers, *Catla catla*, fish, pollution.

Introduction

Fertilizers from nitrogen source are bound to pollute the fresh water ecosystem. The aquatic organisms are the target ones to this alteration in the environment. They exhibit different degree of changes in the behavioral pattern when their habitat is polluted. Agrochemical fertilizers have been shown to have devastating effects on aquatic biota (Bobmanuel *et al*., 2006; Chukwu & Okpe, 2006; Yadav*et al*., 2007). Nitrogen pollution from agricultural sources is now considered to be a major problem in many regions of the world (Vidal *et al*., 2000; Haygarth & Jarvis, 2002).This has originated from human habitation, agriculture and large number of farm animals, such as pigs and cows (Randall &Tsui, 2002). Ammonia makes their presence in water owing to fish excretion. Untreated sewage effluent and/ or seepage from agricultural operations like the application of nitrogen fertilizers contribute to the nitrogen pollution. Clarkson *et al.* (1986) has reported that ammonium is the main inorganic form of nitrogen.

Accumulation of ammonium in water may lead to decreased growth (Thurston & Russo, 1983; Palanichamy *et al*., 1985); changes fish behavior (Rani *et al*., 1997; Wicks & Randall, 2002) and increased vulnerability to disease (Thurston & Russo, 1983). Furthermore, sub lethal ammonium concentrations in water showed inhibitory effects on the enzyme activities of fish (Hisar *et al*., 2004) and caused degeneration on different tissues (Erdogan *et al*., 2005).

Composite fertilizers (NPK) are not classified as hazardous material according to EEC Directive 67/548/EEC (EPC, 1999). As these fertilizers contain phosphates they may cause adverse environmental impact such as eutrophication in confined surface water. NPK, without urea has low potential for bioaccumulation and low toxicity to aquatic life (EIFAC, 1973; EFMA, 2005). Composite fertilizers are used in fish farming to boost the production of algae and diatoms. Chemicals cannot be used directly in freshwater bodies unless their toxicity and sublethal long term effect have been studied on non-target animals, like the fish, sharing the same habitat. (Kabir & Ovie, 2011). Longer studies need to be conducted to determine the long-term effect of fertilization on water quality (Zachary & Martin Petrovi, 2004). The present study therefore investigated the acute toxicity of ammonium sulphate, urea, NPK-1 to fingerlings of fresh water fish *Catla catla* using a static test system.

Materials and methods

Fingerlings of fresh water fish *Catla catla* were collected from the Tamil Nadu fish seed farm Poondi, Thiruvallur district. Fish were held in recirculation systems (200L) for at least 15 days to acclimate to laboratory conditions prior to experiments. During the acclimation period, about 50% of the water in each recirculation system was replaced daily. During the acclimation period and succeeding periods of fertilizers exposure, fish were kept under a photoperiod of 12 hours of light and 12 hours of darkness. Fish were fed with commercial fish feed at 2.5% of their body weight twice a day until 2 days before exposure and not fed during the toxicity tests to evaluate the actual effect of the toxicant. Only commercial grade of fertilizers were used to make it a meaningful study.

The temperature, pH, salinity and dissolved oxygen of the water were found to be 29^0C, 7.66, 0.85‰ and 6.54ml/l respectively. Total ammonia was measured daily by indophenols method (Boyd & Tucker, 1992).

Statistical analysis

Statistical analysis was carried out, adopting the procedure of Altinok and Capkin (2007). The estimated concentration of fertilizers that kill 50% of *C. catla* within 96 hours (96-h LC_{50}) were calculated and tabulated.

Results and discussion

A very few fingerlings of *C. catla* died during the acclimation period, before fertilizers exposure and nil mortality was noted in the control fish group during toxicity tests. In the present study, fish exposed to fertilizers exhibited rapid opercular movement, loss of equilibrium, erratic swimming and frequent surfacing. They remained motionless for a long duration. Later slanting posture of the fish was observed, followed by occasional movement to the surface for gasping. At the time of death, the operculum and the mouth remained

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Table 1. Lethal concentrations (LC_{10-90}) of ammonium sulphate, urea and NPK-1 for the fingerlings of Catla catla

Concentration (g/L) (95% confidence intervals)					
	Point	24h	48h	72h	96h
Ammonium sulphate	LC_{10}	0.15 (0.13-0.15)	0.12 (0.11-0.13)	0.10 (0.08-0.11)	0.08 (0.06-0.08)
	LC_{50}	0.23 (0.21-0.24)	0.17 (0.15-0.17)	0.14 (0.12-0.14)	0.12 (0.10-0.12)
	LC_{90}	0.29 (0.27-0.29)	0.22 (0.21-0.23)	0.20 (0.18-0.21)	0.16 (0.14-0.16)
Urea	LC_{10}	0.31 (0.29-0.31)	0.25 (0.23-0.25)	0.21 (0.20-0.22)	0.16 (0.14-0.16)
	LC_{50}	0.37 (0.35-0.37)	0.28 (0.26-0.28)	0.23 (0.21-0.23)	0.19 (0.17-0.19)
	LC_{90}	0.39 (0.37-0.39)	0.32 (0.31-0.33)	0.26 (0.25-0.27)	0.21 (0.19-0.21)
NPK-1	LC_{10}	0.19 (0.17-0.19)	0.18 (0.17-0.19)	0.17 (0.15-0.18)	0.16 (0.14-0.17)
	LC_{50}	0.32 (0.31-0.33)	0.24 (0.23-0.24)	0.20 (0.18-0.20)	0.18 (0.16-0.18)
	LC_{90}	0.40 (0.38-0.41)	0.36 (0.34-0.36)	0.30 (0.28-0.30)	0.28 (0.26-0.28)

opened. The survived fish were transferred to flow through tanks to observe fish behavior after the 96hrs acute toxicity tests. Fish death continued for one more day. The percentage of surviving fish varied with the fertilizers. Majority of the toxicant freed fishes recovered more rapidly.

Toxicants produce many physiological and biochemical changes in freshwater organisms by influencing their activities. Alterations in the chemical composition of the natural aquatic environment usually affect behavioral and physiological systems of the inhabitants, particularly those of the fish (Radhaiah *et al*., 1987). Fish mortality due to toxicant exposure mainly depends upon its sensitivity to the toxicant, its concentration and duration of exposure (Ram *et al*., 2009) The detection of abnormal activity is based on comparisons of the responses of exposed fish, either with activity measured during a baseline or pre-exposure period or observations of fish under a control treatment (Richmond & Dutta, 1992). The responses of the fish registered in this study were similar to those reported by other authors under various stress conditions (Paul & Banerjee, 1996; Rani *et al.,* 1997; Palanivelu*et al.,* 2005; Ufodike & Onusiriuka, 2008).The toxicity of ammonium sulphate, urea and NPK-1to *C. catla* increased with increasing fertilizer concentration and duration of exposure. The concentration that killed 10% (LC_{10}) and 90% (LC_{90}) of fish varied with the fertilizers (Table 1). Ammonium sulphate was found to be more toxic to the juvenile fresh water fish *C. catla* compared to urea and NPK-1. Ammonium sulphate concentrations killing 50% (LC_{50}) of the fingerlings of fresh water fish *C. catla* during 24hr, 48hr, 72hr and 96hr were 0.23, 0.17, 0.14, 0.12 g/L respectively (Table1).

Nitrogen pollution from agronomic sources is a major problem in many regions of the world (Haygarth & Jarvis, 2002). Nitrogen fertilizers can increase ammonium concentrations in the water (Kumar & Krishnamoorthi, 1983; Gangbazo *et al.,* 1995; Palanivelu *et al*., 2005; Bobmanuel *et al.,* 2006). In water, ammonium exists in two forms, unionized ammonium (NH3) and ammonium ion (NH4+). The equilibrium between the two forms of ammonia is controlled primarily by pH and temperature. These speciation relationships are important in determining ammonium toxicity since unionized ammonia is generally more toxic to aquatic organisms than ammonium ion. In small amounts, ammonium causes stress and gill damage (Smart, 1978; Togham *et al.,* 2001; Wicks *et al*., 2002). In the present study, 96 hours LC_{50} values among the three fertilizers, the toxic effect order was, ammonium sulphate> NPK-1> urea.

Fertilizers might positively or negatively affect the ecosystem quality to the benefit or detriment of live aquatic organisms including fish (Yaro *et al*., 2005).These effects for aquatic organisms moved away from toxic effects of pollutant may be deadly or recover quickly (Kumar & Krishnamoorthi, 1983; Yaro *et al*., 2005).In the present study, all the deaths were nearly 10% after transferring 96 hr toxicity test survivors to flow through tanks, which is similar with previous reports (Xu & Oldham,1997; Little*et al*., 2002).

Conclusion

The present acute toxicity study of ammonium sulphate, NPK 1 and urea (agricultural fertilizers) on the fingerlings of *C. catla* divulges that they are toxic to the fish. The toxicity of ammonium sulphate, urea and NPK-1 to *C. catla* increased with increasing fertilizer concentration and duration of exposure. Ammonium sulphate was found to be more toxic compared to urea and NPK-1. In the present study, the toxic effect order was, ammonium sulphate> NPK-1> urea. The outcome of the present investigation also showed that the fish exposed to these fertilizers recover quickly when they were moved to unpolluted freshwater. It is inferred that application of fertilizers to a larger extent may have toxic potential to the adjacent shallow water bodies, posing a threat to their inhabiting freshwater fish fauna.

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Indian Journal of Science and Technology Vol. 4 No.7 (July 2011) ISSN: 0974- 6846

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