Short Communication

Synergistic and Antagonistic Effects of Atrazine (Herbicide) with Organophosphorothioate (Pesticide)

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ABSTRACT

Atrazine is a selective triazine herbicide, which is a common contaminant of surface waters. This paper discusses its synergistic as well as antagonistic effects in combination with organophosphate pesticides, and the implications arising therefrom.

Key Words: Atrazine, Organophosphate, Herbicide, Pesticide

Introduction

Atrazine (2-chloro-4-(ethylamine)-6-(isopropylamine)-s-triazine) is a selective pre- and post-emergence triazine herbicide applied to many major food crops including corn, sorghum, and sugarcane, as well as to control broadleaf weeds and grasses in residential and commercial landscaping.[1]

Discussion

Atrazine is a common contaminant of surface waters, usually detected in concentration range of 0.5 microgram to 100 microgram.[2] Recently, atrazine residues have been reported as high as 700 and 2300 μg/L in the ground water of 13 states, and in the surface water of 31 states, respectively, during the peak application periods of spring and early summer. Atrazine only accounts for 60% of the total mass of pesticides used each year, and over 85 million applier annually.[3,4] Atrazine is designed to hinder photosystem II and repress electron transport mechanisms necessary for photosynthesis. It is synergistic as well as antagonistic in effect, in combination with organophosphate pesticides.

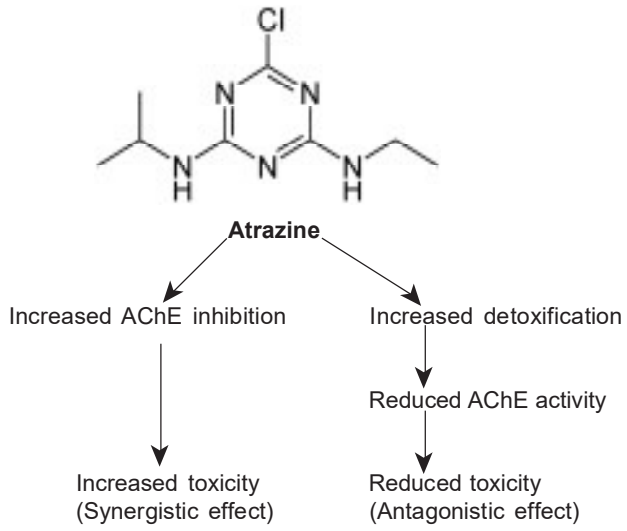

Fig. 1 Synergistic and antagonistic effect of atrazine with organophosphorothioate

Synergistic Effect: Troy in 2004 reported that atrazine has synergistic effect with organophosphorothioate (dimethoate, disulfoton, and demeton-S-methyl) with increased toxicity of 15%, 10%, and 33% respectively in aquatic midges (*Chironomus tentans*).[5] Furthermore, the increased toxicities of dimethoate, disulfoton, and demeton-S-methyl were also correlated with the increased concentrations of atrazine. Atrazine appeared to induce cytochrome P450 monooxygenases in aquatic midges. Thic could be because the elevated cytochrome P450 monooxygenase activity increases the toxicities of dimethoate, disulfoton, and demeton-S-methyl by enhanc-

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ing the oxidative activation of dimethoate into omethoate, and disulfoton and demeton-S-methyl into their sulfoxide analogues with increased anticholinesterase activity.

Binary and territory synergistic (interact joint toxicity) of atrazine has also been demonstrated by Pape-Lindstrom & Lydy (1997).[6] They demonstrated the combination effect of atrazine with organophosphate class of pesticides on *Chironomus tentans.* The binary effect of atrazine with the methyl-parathion, trichlorfon, malathion and chlorpyrifos, as well as the tertiary mixture effect with methyl-parathion and methoxychlor also showed greater than additive responses. The reason for synergistic effect is still not well understood. One of the hypotheses is that the synergistic effect of atrazine may be due to increase in penetration of the insecticides through the midge cuticle, or increase in the cellular permeability of the organophosphates.[7] Another hypothesis is that atrazine may actually increase biotransformation of the organophosphates converting them into more toxic metabolites.

Antagonistic Effect: Atrazine also showed antagonistic effect with organophosphorothioate like omethoate and methoxychlor.[5,6] It antagonized the toxicity of omethoate by 1.34-fold in aquatic midges (*Chironomus tentans*). Furthermore, the increased toxicities of dimethoate, disulfoton, and demeton-S-methyl correlated with the increased concentrations of atrazine, whereas the decreased toxicity of omethoate correlated with the increased concentrations of atrazine. Atrazine reduced the toxicity of omethoate possibly by enhancing the oxidative metabolic detoxification, since omethoate does not require oxidative activation.

Conclusion

Mixtures of the herbicide atrazine with different pesticides have both synergistic and antagonistic effects. Due to increasing use of pesticides, it is always necessary to evaluate the combined effects of various pesticides when administered together.

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