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Photoreactivity of Imazethapyr Herbicide in the Presence of Suwannee River Fulvic Acids

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In the present work, the photoreactivity of imazethapyr herbicide in water in the presence of Suwannee river fulvic acids is reported.

Key Words: Fulvic acids, Photo degradation, Imazethapyr.

INTRODUCTION

Humic substances representing the main fraction of organic matter[1] receive increased attention because of their reactivity as sunlight absorbers. Depending on their origin, humic substances have a remarkable ability to absorb light and transfer this energy to other substances and in some cases strongly affect photolysis of xenobiotics. In water and in soils humic substances have been found[2] to act as photosensitizers when irradiated at wavelengths longer than 290 nm and they have also been reported to produce oxygen species upon irradiation[3] and be able to photo-induce the transformation of pesticides[4, 5]. They could behave as quenchers or as light scatterers[6].

The herbicide imazethapyr (IMAZ), (RS)-2-(4-isopropyl-4-methyl-5-oxo-2-imidazolin-2-yl) nicotinic acid is a herbicide widely used to control a wide range of weeds[7]. It has been tested for weed control in cereal crops and sugar beet in Morocco. It is highly soluble in water (11.3 g/L); however, concentration of imazethapyr which would be found in surface and groundwater will exceed the CE limit (0.1 μg/L) and will be a potential pollutant of water.

We have examined the photoreactivity of imazethapyr in water in the presence of Suwannee river fulvic acids (FAs). The information provided by this study could be of aid in the understanding of the environmental behaviour of this herbicide.

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EXPERIMENTAL

Imazethapyr (Fig. 1) was purchased as certified standard from commercial source at purity higher than 99%. All other reagents used were of analytical or HPLC grade. The fulvic acids of Suwannee river (IHSS samples) used in this investigation were kindly given by Professor Frimmel, University of Karlsruhe, Germany.

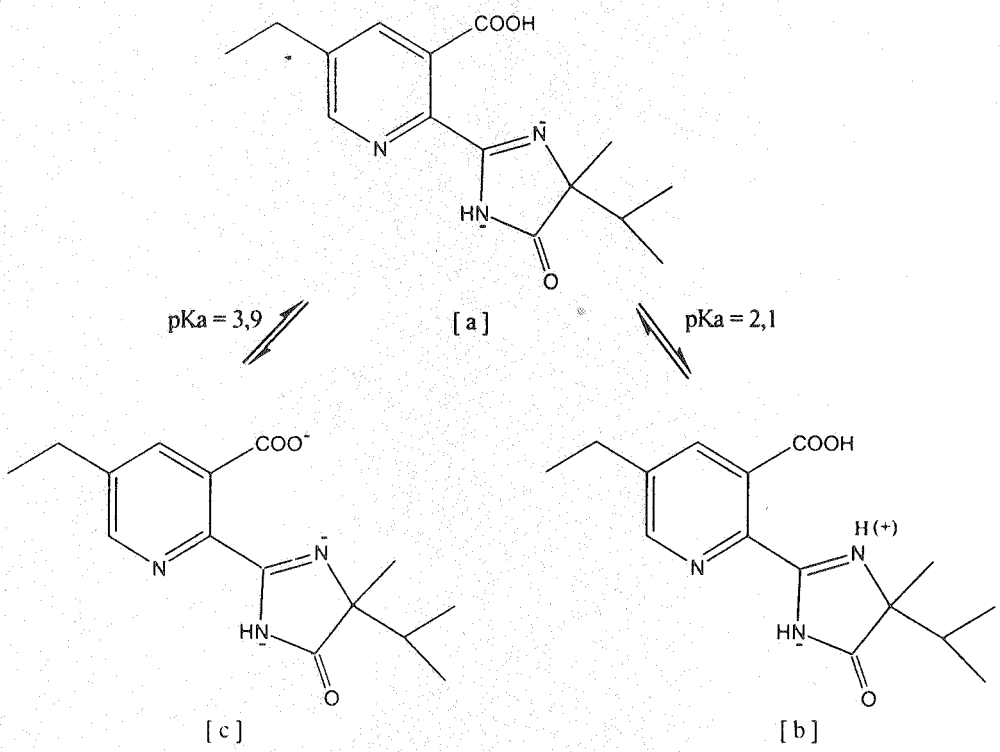

Fig. 1. Imazethapyr protonation/ionization

Photoreactor: Photo degradation processes were carried out using an HPK photo reactor. The irradiation source was HPK 125 W (T = 20°C), which provided a good simulation of solar light at wavelength greater than 290 nm. The solution was homogenized by continuous stirring with a magnetic stirrer.

Procedure

Simultaneous photo-reactivity of imazethapyr and fulvic acids at different mixtures of fulvic acids/herbicide (1 : 1 by volume) were used. 50 mL of solution was exposed for photo degradation at various illumination times. Experiments were carried out at pH = 7.0 (pH of environmental interest), buffered with a mixture of K_2HPO_4 (3.9×10^{-4} mol/L and K_2HPO_4 (6.1×10^{-4} mol/L (1/1 v/v). The disappearance of imazethapyr at various illumination times was determined after filtration by using Spectra Physics model Varian 9100 HPLC system equipped with UV detector at 230 nm and C_{18} column (25; 4.6 id). A mobile phase was made by 75% water and 25% acetonitrile adjusted to pH = 3.1 by formic acid. Retention time was 5.6 min.

RESULTS AND DISCUSSIONS

Fulvic acids properties

The characteristics of fulvic acids (Table-1) used are close to those reported in the literature data with some differences in the determined chemical properties such as total acidity and acid group.

TABLE-1
ANALYTICAL CHARACTERISTICS
OF FULVIC ACIDS USED

C (%)	52.44
H (%)	4.31
N (%)	0.72
O (%)	42.20
Ash	0.46
H_2O	8.80
Phenolic acidity (meq/g)	2.91
Carboxylic acidity (meq/g)	11.44

Photolysis

The results of the effect of the presence of FAs on photolysis of IMAZ in water are reported in Table-2. The photoreactivity of imazethapyr in the presence of fulvic acids of Suwannee river follow a first order kinetic (Figs. 2 and 3). The photochemical behaviour of fulvic acids isolated from Suwannee river which have a complicated molecular structure has induced an increase of photolysis rate with respect to pure water solution of IMAZ molecules.

According to the results given in Table-2, the addition of the fulvic acids to the

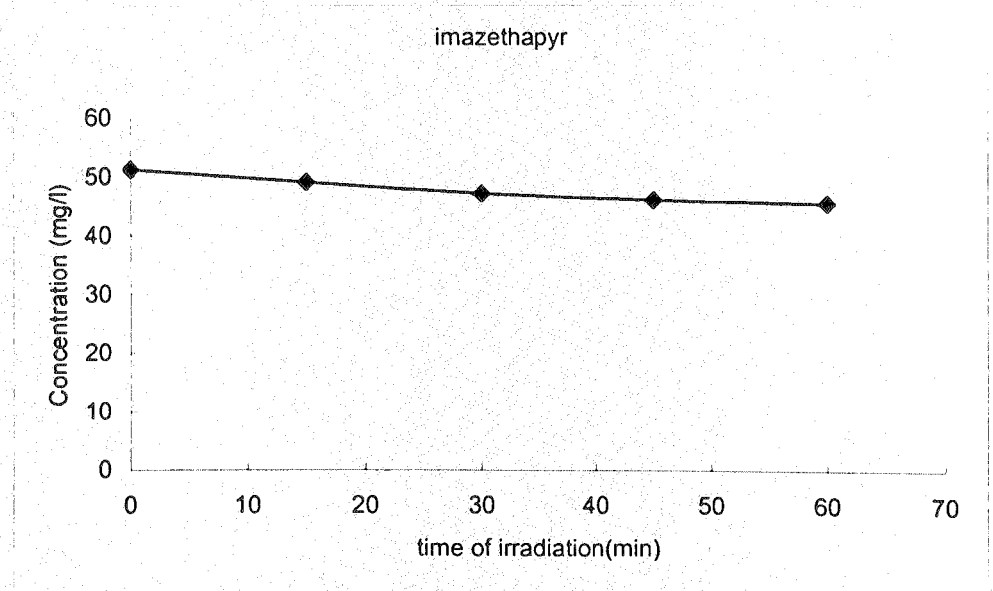

Fig. 2. Photolysis of imazethapyr in water solution

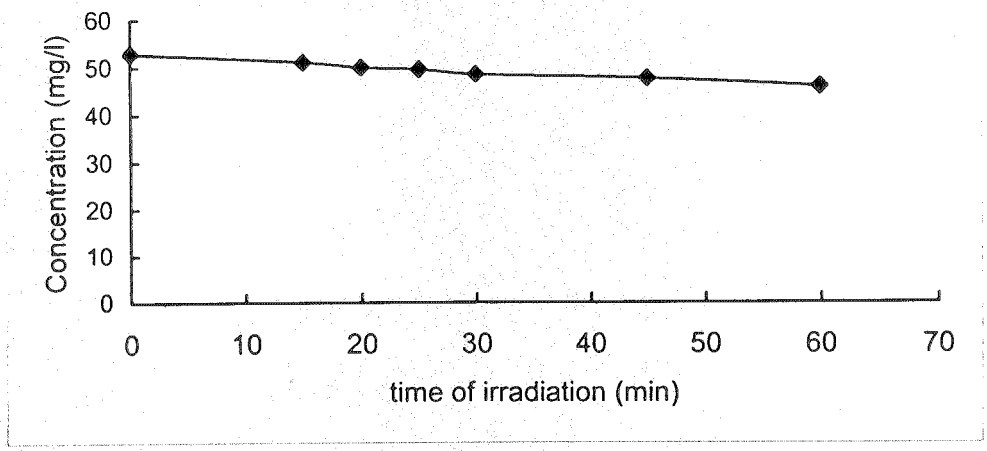

Fig. 3. Photolysis of imazethapyr in water solution in the presence of fulvic acids

solution of IMAZ herbicide results in a decrease in the half-life ($t_{1/2}$). The result obtained clearly demonstrates that fulvic acids substances exhibit a photo-inductive effect on the photochemical degradation of this herbicide.

The photo-inductive effect of fulvic acids on the IMAZ degradation could be explained by the ability of fulvic acids used to absorb light and transfer this energy to IMAZ molecules.

TABLE-2
KINETIC PARAMETERS OF PHOTOLYSIS OF IMAZ IN THE PRESENCE OF FULVIC ACIDS

	IMAZ	
FAs/herb	K (min^{-1})	$t_{1/2}$ (min)
0/1	0.0025	277
1/1	0.0028	247

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