Photochemically-induced fluorescence (PIF) and UV-VIS absorption determination of diuron, kinetic of photodegradation and rate of leach ability in soils

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INTRODUCTION

Anti-parasitic products for farm like pesticides are widely used in Senegal and in the near under-region. Most of these compounds present a great photochemical instability and are rapidly degraded in our country characterized by a very sunny and warm dry summer climate.

OBJECTIVES

With the aim of finding analytical methods able to solve problems related to pollution and toxicity, therefore intended to safe the use of pesticides, we have undertaken a study for diuron used in agriculture in Senegal. The herbicide diuron is frequently detected both in surface and groundwater. Its persistence, resulted in it becoming common pollutant in soil and water. In this work, we use UV irradiation to degrade diuron and monitored the photoproduct using two methods: the absorption and fluorescence spectrometry. Therefore, we developed and evaluated several physicochemical studies including, kinetic of photodegradation in aqueous media and the determination of rate leach ability in soils.

METHODOLOGY

Reagents and Soils

Diuron (97.5 %, m/m) was purchased from Cluzeau Info Labo (France). Spectroscopic-grade solvents were from Merck (Darmstadt, Germany). Dune soils samples were collected from Malika (Dakar) in a coastal agricultural area called "Niayes area".

Apparatus

Spectrophotometer Helios Gama; Spectrophotofluorimeter Kontron; SFM-25. An Osram 200W HBO high pressure mercury lamp.

Soils leaching procedure

Leaching was studied in a PVC laboratory made hand-packed soils column (50 cm long, 12 cm diameter) sealed at the bottom with a fine mesh in order to retain soil and permitting a regular stream of the leachate. The leachate stream were maintained constant at the value of 0.5 mL/min by the mean of a separatory funnel filled with distilled water.

Tab. 1: Kinetic parameters of the diuron photolysis reactions in different media

Solvent	λ_{ab} (nm) [a]	ε (mol⁻¹.l.cm⁻¹) [b]	K [c] min−1 or M−1 min−1	t1/2 (min) [d]	Order [e]	r^2 [f]
Acetonitrle	250	1.9 x 10^4	114,5 (± 9.2)	87.5	2	0.989
Water	248	1.8 x 10^4	362 (± 21.7)	27.6	2	0.997
Methanol	248	2.3 x 10^4	1,8 (± 0.05)x 10^{-2}	37.5	1	0.999

[a] Maximum absorption wavelengths. [b] Molar extinction coefficient values. [c] Photolysis rate constant (min−1 or M−1 min−1) and absolute error (±). [d] Photolysis reaction half-life time (min). [e] Reaction kinetic order. [f] Kinetic equation correlation coefficient.

Tab. 3: Analytical figures of merit for the PIF determination of diuron

Solvent	LD (nm) [a]	LQ (nm) [a]	r^2
Cyclohexane	8.5	28	0.986
DMSO	96	317	0.993

[a] LOD = limit of detection. [b] LOQ = limit of quantification.

MAIN RESULTS

Diuron is very persistent in water under light effect. Hence we have to consider the risks of contamination of surface water by streaming or ground water through infiltration (tab. 1 and Fig. 1).

The very low LOD values obtained in cyclohexane suggested that PIF method can be considered as a convenient and very sensitive for the determination of diuron in environmental matrices (tab.3).

A study destined to evaluate the rate of leach ability in soils has been conducted in agricultural soil. The obtained rate of infiltration is 12.7 mm/min which show that diuron has high potential of pollution of ground waters.

CONCLUSION

Diuron with a weak lifetime but a high rate of leaching is in the position to contaminate ground waters allowing it to escape partially from microbial degradation. From a public health standpoint, it would be very useful to determine the content of diuron in soils, surface water and ground waters. However, in all cases, PIF method could be used to monitor the herbicide with satisfactory results.

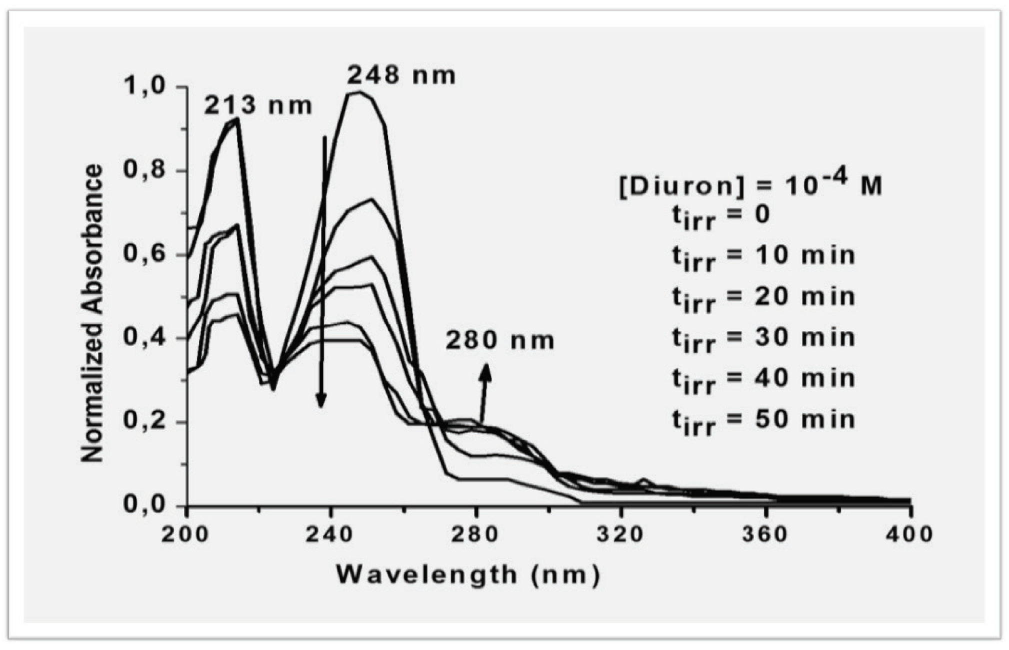

Fig. 2: Influence of the UV irradiation time on the normalized absorbance of diuron in water

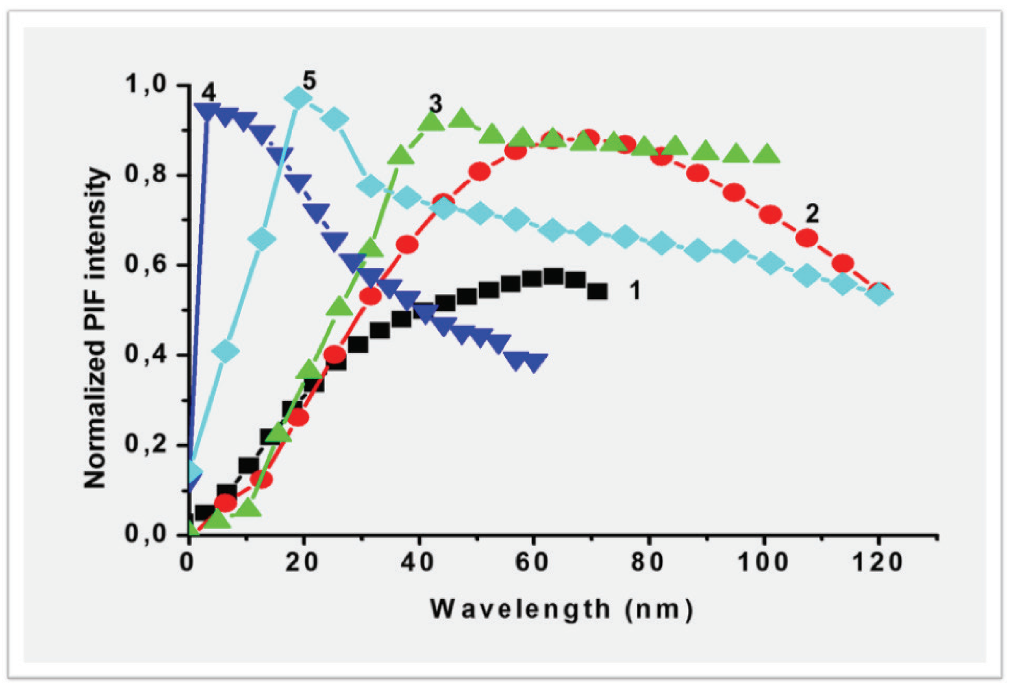

Fig. 3: Influence of the UV irradiation time on the normalized PIF intensity of diuron (10^{-5} M) in different solvents: Water pH12 (1), acetonitrile (2) methanol (3), cyclohexane (4), DMSO (5).

Tab. 2: Medium effect on the diuron PIF properties and photolysis reaction kinetics

Solvent	λ_{ex} (nm) [a]	λ_{em} (nm) [b]	t_{opt} (min) [c]	I_{PIF} [d]
Cyclohexane	348	405	5	1.64
Methanol	320	414	45	1.60
Acetonitrile	333	408	60	1.54
DMSO	342	410	20	1.71
Water	345	433	45	1.00

[a] Maximum PIF excitation wavelengths. [b] Maximum PIF emission wavelengths. [c] optimum irradiation time. [d] IPIF = normalized relative PIF intensity, relative to water (IPIF =1.0).

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