EFFECT OF MICROENCAPSULATION ON PHOTODEGRADATION OF NORFLURAZON IN SOIL-WATER SYSTEM

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INTRODUCTION

Controlled-release technology, as microencapsulation technique is being used to prevent pesticide environmental pollution due to their advantages over conventional formulations such as reduce pesticide losses from degradation, leaching, or volatilization. Likewise, investigation of the photolysis of pesticides is important because of its influence on their fate and its persistence in natural environments exposed to sunlight. For this reason, the photodegradation of these compounds has been studied in detail in aqueous solution systems, and few studies have examined photodegradation in soil or its colloidal components. This would be a more realistic approach, since natural waters contain a variety of dissolved, colloidal, and suspended organic and mineral constituents from soil.

Norflurazon (NFZ) is a fluorinated pyridazinone herbicide that suffers losses when it is applied to soil. Photodegradation contributes significantly to field dissipation when the herbicide remains on the soil surface. Leaching also plays an important role in NFZ losses in agricultural applications, which determines its presence in groundwater. Microencapsulation has been observed to increase the persistence of NFZ (1); however there is currently no information on the influence of microencapsulation on the NFZ-photodegradation.

To compare the NFZ-photodegradation applied as **microencapsulated formulation** with the **commercial formulation (CF)**, experiments in aqueous suspensions of different soil components and in soil were carried out.

MATERIALS AND METHODS

Herbicide: **norflurazon Commercial formulation (CF): Zorial 80, Syngenta Agro S.A.**; Ethylcellulose: **Ethocel 40 (EC40)**. Soil: Loamy Sand, pH 8, 0.92% OM, 6.9% $CaCO_3$. **Ethylcellulose microencapsulated formulation (MEF)** was obtained by solvent evaporation technique, using chloroform as internal phase, 0.15 % of **PVA** as **emulsifying agent : Herbicide Loading 15.9 %, Encapsulation Efficiency 78%** (2).

Soil colloidal components:

SWy Montmorillonite (Mo) from Source Clay Minerals Repository, USA

Synthetic humic acid (HA) from FLUKA

Natural metal-fulvic acid complex (FA), from a Typic Haphorthod soil, Scotland

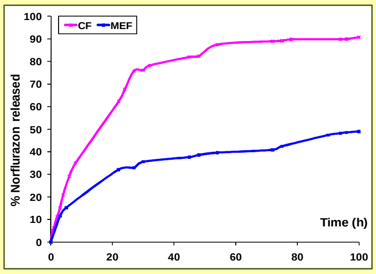
Synthetic acicular goethite (Go), specific surface area of 43 m^2 g^{-1}, point zero of charge 8.2

In vitro release studies: Microspheres containing 5 mg of norflurazon were added to 1l of distilled water and stirred. Samples were taken at time intervals to determine the herbicide dissolved.

Photodegradation studies: were carried out with a Suntest CPS photoreactor (Heraeus, Hanau, Germany) equipped with a Xe lamp (500 W/m^2) with a permanent filter, which selects a wavelengths ≥ 290 nm. An aqueous NFL solution (250 ml, 20 mg l^{-1}) applied as CF and MEF was magnetically stirred and irradiated in quartz flasks during 32 hours. The same experiment was carried out in the presence of 20 mg of different soil components and in Petri dishes, containing 10 g the soil and 100 mg/Kg of NFZ . Dark control experiments were conducted in a similar manner and the samples collected at different times were filtered (0.22 mm Millipore glass fibre membrane) and the NFZ concentrations measure by HPLC.

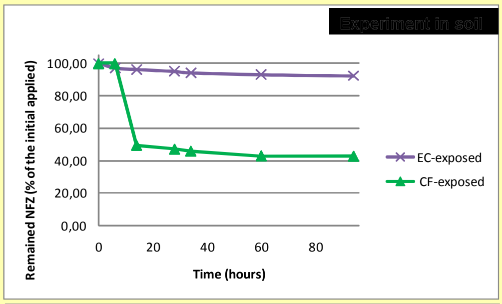
RESULTS AND DISCUSSION

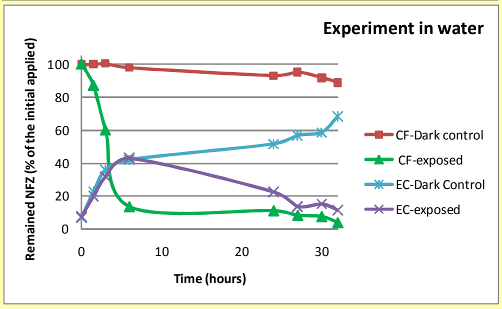
In vitro release studies



Norflurazon photodegradation in water and soil

The MEF protected against photodegradation in soil and in aqueous solution longer than CF, which can be attributed to the gradual release of the herbicide into water from MEF (1). This sustained release compensate the processes of NFZ photodegradation in soil and in aqueous solution, where no NFZ photodegradation from MEF is observed during the 6 first hours of light exposition. Likewise, this effect explains that the remaining herbicide in the system from MEF (43.29%) is higher than that from CF (4.02%) .





Effect of soil component on Norflurazon photostability

Sample	(%) NFZ degraded	Norflurazon remained (% of initial): In solution – Control	In solution – Exposed	Encapsulated – Control	Encapsulated – Exposed	Total in the system – Control	Total in the system – Exposed
Water-CF	84,87	88,89	4,02	0,00	0,00	4,02	4,02
Water	56,71	68,32	11,61	31,68	31,68	100,00	43,29
Goethite	3,81	74,11	70,30	25,89	25,89	100,00	96,19
HA[a]	40,75	63,15	22,40	36,85	36,85	100,00	59,25
FA[b]	54,44	57,61	3,17	42,39	42,39	100,00	45,56
Mo[c]	50,97	53,33	2,36	46,67	46,67	100,00	49,03

HA: Humic acid
[b]FA: Fulvic acid
[c]Mo: Montmorillonite

The different soil colloidal components in aqueous suspension provoked the reduction of the NFL photodegradation rate, due to a screening effect, especially when goethite and humic acids were present. The NFZ photoprotective effect of Go and HA is attributed to the herbicide sorption ability to the soil components (3). In presence of Go, the NFZ remained in solution was similar in darkness (74.11%) and under irradiation (70.30%), which indicates that NFZ was not adsorbed on the oxide surface, whereas the HA protection is attributed to the herbicide adsorption on this component that would cause a deactivation of the excited herbicide molecule.

CONCLUSIONS

The controlled release provided by the microencapsulation of norflurazon in ehylcellulose protects against its photodegradation either in water or soil. The presence of different soil components in aqueous medium did not decrease the photoprotective effect of the microencapsulated formulation, which implies that the active ingredient can be biologically active longer than in the commercial formulation, so that the use higher application rates of the herbicide is not necessary, with subsequent decrease in environmental contamination risks.

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(3) J Villaverde, Maqueda C, Undabeytia T, Morillo E (2007) Effect of various cyclodextrins on photodegradation of a hydrophobic herbicide in aqueous suspensions of different soil colloidal components Chemosphere 69: 575-584.