RESEARCH ARTICLE **(Open Access)**

Impact of herbicides upon the dynamic of the organic carbon in soils

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Abstract

The study focuses on the effect of two herbicides H1 Topic and H2 ZOOM, on carbon mineralization in two types of soil (sandy-clay and sandy) of the area of Ben M'hidi (Algeria). These herbicides are frequently used as means of wrestling against weeds which invade wheat field and culture of gardening. The results of our study highlight the variable effects of these weeds upon the production of carbon dioxide followed by depressive actions toward the microflora of soil with reducing the activity of micro-organisms. With highly the increasing dose, every soils confused, these effects are more evident with Topic rather than ZOOM, whose excess can have possible consequences of groundwater. Pollution can be avoided or limited by contributions of organic fresh material which further the reorganization of humic elements and avoid leaching.

Key words: sandy-clay, sandy, mineralization, microflora, microorganisms.

1. Introduction

The agriculture intensification through the increased use of soils fertilizers and pesticides aims to compensate nutritional deficits and to limit the proliferation of predators in order to ameliorate the agricultural production and ensure its durability often with difficult consequences in terms of environment.

And the use of herbicides to increase agriculture production has been the subject of numerous studies. Some are interested to the degradation of these products by their mineralization in soils [4, 2, 6], others are interested on the phenomena adaptation and desorption of these molecules in soils [4, 9, 10], while in some studies the emphasis was placed on the effect of these herbicide on soil properties [7, 11].

In Algeria, the usage of quantitative and qualitative, but disorganized in general, of pesticides, is common as agricultural practice. This may be due to its climate and the biological activity in soils that these elements undergo a better dynamic.

Among many homologous pesticides in Algeria; forty are widely used by farmers [3]. During the spraying, only 1% of the used quantity of herbicides arrives to weed's level. Much is lost in the environment that it can pollute according to soils quality cultural techniques.

Despite their advantages, these compounds are by their chemical nature [4], very active biologically. Their toxic effects possibly represent potential risks to human health, wildlife and the environment [1].

But what are exactly their effects on soils, and particularly on soil microorganisms? Would be there a specific effect of humus, of clay colloid content and of porosity on the effect of herbicides? Therefore, what would be the reaction microbial groups towards these pesticides? Can we speak of a soil type on the future of these products in agricultural soils? Is their a toxic effect of these substances taht may cause a malfunction of soils? What is the relative importance of this secondary effect; often take into account these considerations?

Our study focuses on the characterization of effects of two types of herbicides, the Topic and the ZOOM upon microbial activity, and especially upon carbon mineralization in two soils of region of Ben M'hidi (Tarf-Algeria).

2. Material and methods

2.1 Soils sampling

Sampling of soils to a depth of 0-3cm; One with texture sandy-clay and the other with texture sandy. We have proceeded to the sampling of soils on the depth of 0-30cm, one of a clay sandy texture (region of Sidi M'barek) and the other of a sandy texture (region of Ghourd El Bourk).

2.2Choice of herbicides

The used herbicides are these employed by farmers to fight against weeds.

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-Topic 080 EC: it is used against weeds (wild oat raygrasse) of wheat fields. It is not dangerous for cereals. The best effect is obtained in condition of foaming vegetation with a fast effect found during the 48 hours of its application. Chemically, the Topic has the following composition: 80g/l Clodinafop-propargyl: ($C_{17}H_{13}ClFNO_4$), and 20 g/l Cloquintocet-mexyl: ($C_{18}H_{22}ClNO_3$).

-ZOOM, its fast effect is followed by leaves destruction and roots of weeds. Chemically, the ZOOM has the following composition: triasulfuron (4,1%): $C_{14}H_{16}ClN_5O_5S$ and Dicamba (65,9%): ($\underline{C_8}\underline{H_6}\underline{Cl_2}\underline{O_3}$).

2.3 Phsyco-Chemical Characterization of Soils

It focuses upon the following characteristics; particle size, water retention capacity, drying capacity of cationic; pH; total limestone; total organic carbon; organic material; total nitrogen and assimilable phosphorus.

In order to avoid the alteration of potential microbiological, samples are first preserved to a temperature of 4°C temperature. Incubation for carbon mineralization was carried out according to the technique of respirometry by titrimetric (T° of 25°C, humidity 2/3 of c.r.water).

2.4Experimental Device

The experimental technique employed in this study is the method of respirometry. The CO2 of the microbial activity from only soil or of mixing soil-herbicides is trapped in a solution of sodium hydroxide (0,2N). The excess of NaOH is dosed with HCL (0,5N) in the presence of phénolphtaleine after having done precipitating carbonates by BaCL2 (20%).

We followed the kinetics of carbon mineralization in order to characterize the interactions between the microbial activities, doses of weed-killer and types of soils (table 1).

Table 1: Characteristics analysis of the total carbon expired

Characteristic	
NaOH	0,2 N
amount	20 ml
Trapping frequency (angular points)	1, 3,7, 14, 21, 28, 42 et 60 days
Duration of follow	60 days

Samples of soil (25g) moistened (2/3 c.r.water) and mixed with weed-killer, were placed inside sealed vial (to 2/3 of the retention capacity, and incubated at ambient temperature (25°c).

The treatment in three repetitions focuses on ten samples.

For plants-herbicides, doses of application are of 0, 9 l/2001 of active material/ ha for Topic and of 120g/200l of active material / ha for ZOOM.

2.5Carbon Mineralization in Soils

The study of carbon mineralization in soils and particularly its intensity requires the use of coefficient of carbon mineralization:

CM carbon soil-herbicide = Cco_2min (soil +herbicide).100/Cco_2 (soil+herbicide).

The formula of evaluation of percentage of inhibition or of stimulation of a given treatment relative to witness is as follows: % inhibition =1 - % degradation of treatment / % degradation of witness.

2.6 Treatment of Data by Statistical Method

The experimental plan in totally random blocks corresponding to a factorial system 5x2 (five treatments and two soils), with 3 repetitions and 7 dates.

Data were treated by method of analysis of variance to one factor and to two factors (ANOVA) and by the correlation method in a simple declining using Minitab 13 (D).

3. Results and Discussion

3.1Interpretation of Analytical Data of Soils

The analytical data characterize the physico chemical differences between clay-sandy soils and sandy's (table 2). Besides the textural specificity taken as a sampling reference, clay soils present high significant values of a good fertility in comparison to those of clay-sandy soils which are characterized by a week level of fertility.

3.2 Effect of Weed-Killers upon the Organic Carbon Mineralization

-Effect of Weed-Killers on Evolution of Organic Carbon Mineralization: The examination of results (table 3), reveals a negative effect of weed-killers (in d1 and d2) on the mineralizing germs of organic carbon into sandy soil. The herbicide ZOOM seems to exercise a more toxic effect toward the

Table 2: Physico-chemical properties of the soils studied - Ben Mhidi (Tarf)

Physico-chemical properties		**soil1 (Ghourd el bourk)**			**soil 2 (Sidi m'barek)**		
Size %		**clay**	**silt**	**sand**	**clay**	**silt**	**sand**
		36	20	44	0	8	92
textural class		Clay-sand			Sandy		
pH		7,43			7,65		
Electrical conductivity (us / cm)		106,00			50,15		
Water holding capacity (%)		33,54			19,45		
Limestone total (%)		traces			traces		
K(ppm)		183,10			37,00		
Na (meq/100g)		0,35			traces		
Mg (meq/100g)		1,84			0,31		
Ca (meq/100g)		18,82			-		
CEC (meq/100g)		70			19		
P (olsen) (ppm)		9,30			0,49		
N(%		0,13			0,04		
N min	NH_4^{+}(ppm)	5,3			5,3		
	NO_3(ppm)	15			15		
N org (ppm)		235			360		
C (%)		1,92			0,4		
MO (%)		3,30			0,69		
C/N		14,76			10		

Table 3: Inhibition rate of herbicides in both clay and sandy soils

herbicides	*Topic d1*		*Topik d2*		*ZOOM d1*		**ZOOM d2**	
sols	S1	S2	S1	S2	S1	S2	S1	S2
dégradation%	90 %	71 %	126 %	65 %	66 %	58 %	57 %	49 %
inhibition%	10 %	29 %	26 %	35 %	34 %	42 %	43%	51 %

Table 4: Analysis of Variance

	Source of variation (SV)	*Ddl*	*SCE*	*Mean square*	*F calculated*
soil 1	Factor	4 (K 1)	25075,99	6268,998	
	Remaining	30(K2)	63167,1	2105,57	2,977341*
	totaux	34	88243,09		
soil 2	Factor	4 (K 1)	32150,01	8037,502	
	Remaining	30(K2)	34932,3	1164,411	6,902631***
	total	34	67082,31		

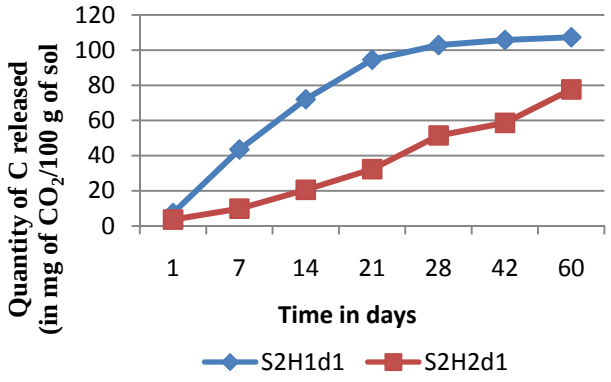

Figure 1: Effect « Kind of Herbicide » to dose 1, on Organic C Mineralization in Soil S2

mineralizing microflora of CO into sandy soils whereas the Topic is of a less pronounced effect. According [10, 6], toxicity would be due to the reduction of microbial strains under the effect of weed-killers and that the unfavourable effect would alter the microbial metabolism. According to [1], the week degradation would be done by a microbial co-metabolism, or although these pesticides fix enzymes and decrease microbial activity in soils.

Into clay soil (table 4), ZOOM (a d1 and d2), exercise a depressive effect on CO mineralization, possibly with the inhibition of responsible enzymes of microflora respiration. The effect of of Topic is variable according to dose in which the increase seems to stimulate a little bit the activity of mineralizing germs of CO into clay soil.

The toxic effect of ZOOM or with some stimulation of microflora under the effect of weed-killers by [7], when the possibility of reduction of inhibitor power of weed-killers, by the humic complex and clay minerals. Besides, killed strains become

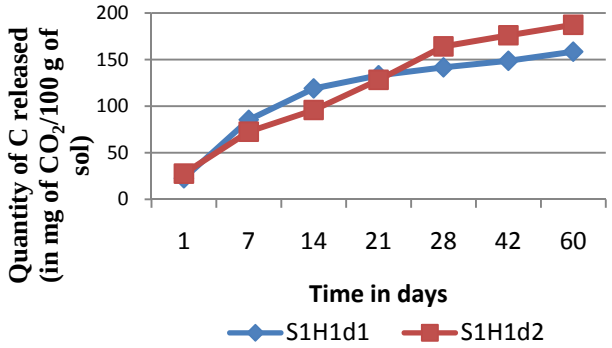

Figure 2: Effect of Dose Topic on Organic Carbon Mineralization in Soil S1

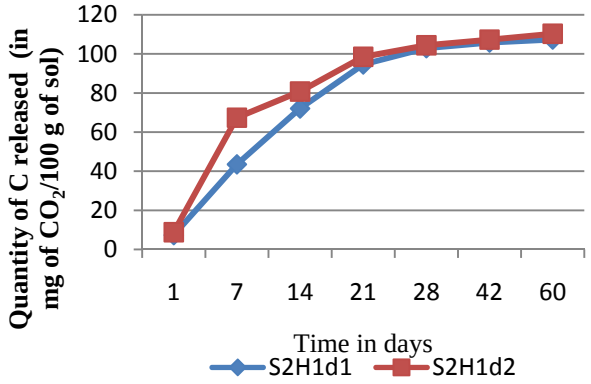

Figure 3: Effect of doses of Topic on Organic Carbon Mineralization in soil S2

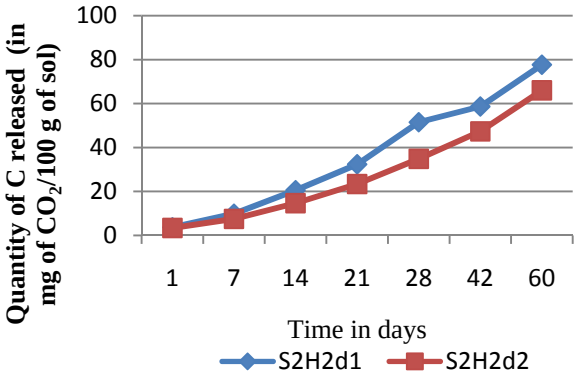

Figure 4: Effect of Doses of ZOOM on Organic Carbon Mineralization in Soil S2

eventually an additional source of carbonaceous substrate readily biodegradable by soil microflora [2].

Concerning the relative importance of the effect of weed-killers on organic carbon mineralization of soils, the analysis of variance revealed very significant differences in terms of mineralization between witness systems and soils/herbicides systems (d1and d2) (Fobs1= 6,902631***et Fobs2=2,977341**) (table 4).

Type Effect of Weed-Killer on the Evolution of Organic Carbon Mineralization (Figure 1):

In soil1-ZOOM (d1) system, it appears that this latter has a depressive effect much more increased toward microflora into clay soil. We have the same into sandy soil, where we have noticed a negative effect of ZOOM in relative to Topic. Similar results were observed by [12], justifying this latency phase by the inhibition of microbial activity. When the toxic effect of ZOOM on mineralizing germs, it is according to [8], explained by the presence of chemical products sulfonyrées and benzoic acid having biocidal properties.

To statistical plan, the analysis of variance shows that a very significant difference exists between the witness system and soils-herbicides system to productive quantity plan of CO2, where the very significant influence on CO mineralization into the two soils.

-Herbicide dose Effect upon the Evolution of Organic Carbon Mineralization: According to figure 2, the weed-killer Topic (a d1) presents a stimulated effect of microflora into clay soil. The effect is inhibitory with the increase of dose. Into sandy soil under effect Topic (d1 and d2), follows an action of stimulation.

The most persistent and amplified effect occurs by increased contribution of bacteria to total inhalation. With ZOOM d1 and d2, the inhibitory effect increases significantly with dose (figure 4).

3.3 Weed-Killers Influence upon the Intensity of Organic Carbon Mineralization

- Effect of the Topic on the evolution of coefficients of Organic Carbon Mineralization (Figure 5): Whatever the Topic dose is, the coefficients of mineralization, are slightly variable and decreased into soil 1, saving values clearly inside in relative to those into the control soil. It would seem that Topic provokes a negative effect causing death to some microbial strains. After repeated applications of trifluraline upon mushrooms populations, it is found an important reduction of mushrooms and bacteria, on the other side, the actinomycetes probably increase because of their ability to metabolize this pesticide. With the persistence of degradation rates the risks of pollution groundwater are predictable.

According to figure 6, it is noticed a dynamic of week mineralization due to the limited effect of microbial biomass in its degradation of a product part. According [9], the rest is either adsorbed by the complex clay-humic or degraded by co-metabolism under a form of microbial metabolite into soil.

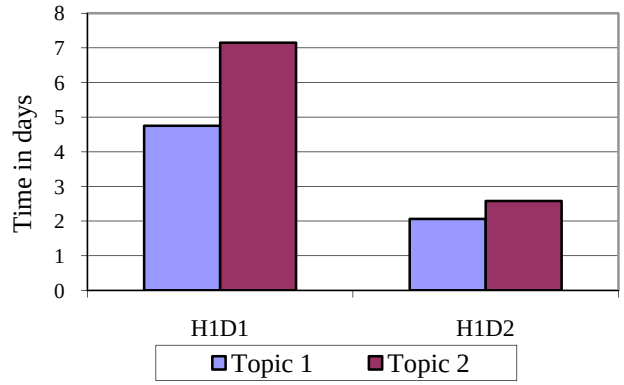

Figure 5: Evolution of Coefficients of Mineralization in Soi

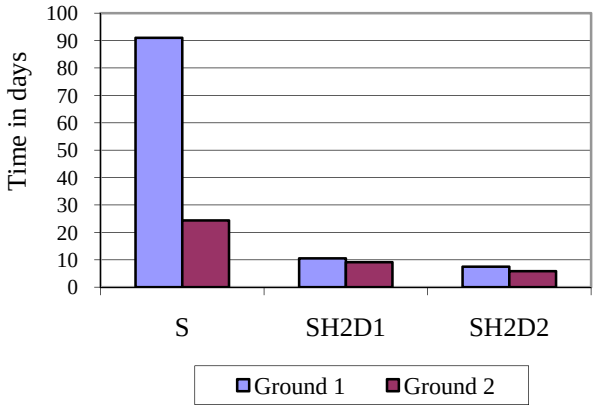

Figure 6: Coefficient of Topic Mineralization in Soils

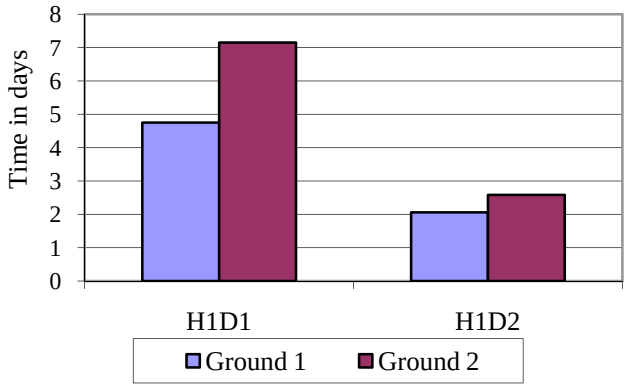

Figure 7: Evolution of Coefficients of Mineralization in Soil

-Effect of ZOOM on the Evolution of Coefficients of Organic Carbon Mineralization: Figure 7 illustrates the variation of coefficients of mineralization into clay soil which would be either due to the toxicity of ZOOM towards some microbial strains of soil, or to a modification of a microbial metabolism or much more to an inhibition of the enzymatic synthesis. This effect becomes more toxic

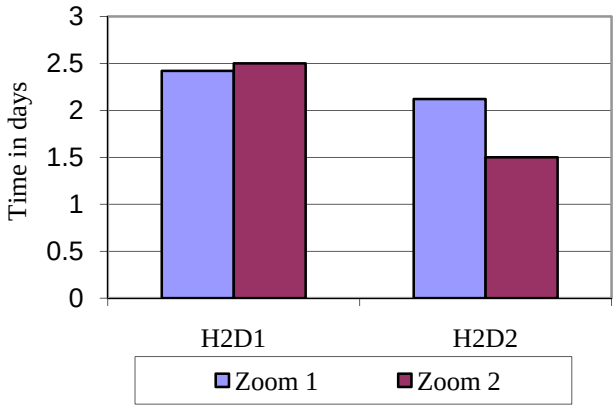

Figure 8: Coefficient of ZOOM Mineralization in Soils

and mineralization rate becomes even lower when ZOOM is added in large quantities. These results are similar to those recorded by [5], in their work confirming the effect of a high concentration of the herbicide 2.4 D on the strong inhibition of mineralization. These results are confirmed also by [12] who estimated that the initial concentration of herbicide, metamitron affects the pace of kinetics degradation.

The evolution of ZOOM (d1 and d2), in clay soil with week rates, translates a degradation followed of an inhibitory effect of this pesticide towards germs of organic carbon mineralization. It is also possible that this breakdown of the herbicide but be low due to microbial co-metabolism or action of physico-chemical properties of the soil.

-Effect of Topic on the evolution of coefficients of Organic Carbon Mineralization into Sandy Soils: In soil 2 (sandy), the evolution of CM values compared to those of control (figure8**)**, explain an inhibitory effect more harmful on microflora to dose d2, can be due to the reduction and/or the elimination of some microflora. It is also possible that this breakdown of the herbicide but be low due to microbial co-metabolism or action of physico-chemical properties of the soil.

The appearance of kinetics of degradation, probably because of its low levels of humus and colloidal clay, depends on the initial concentration of herbicide. Coefficients of mineralization ate week a d1 or a d2 due to light texture soils that are more favourable to a greater degradation of herbicides.

- Effect of ZOOM on the Evolution of Coefficients of Organic Carbon Mineralization into Sandy Soils: According to figure 9, under the effect of herbicide ZOOM (a d1), the variations of coefficients of mineralization in sandy soils, explain a

strong reduction this parameter. The effect dose which is very negative would be due to a strong toxicity of products opposite to mineralizing germs. After finding these effects during their work, Mazzatura (2001) thought that this herbicide plays a role of biocide. As rates are very low to D2, this herbicide induces a very depressive effect on mineralizing germs of endogenous carbon of soil and carbon of herbicide itself.

4. Conclusions

The results obtained after different treatments of two soils clay and sandy with two herbicides Topic and ZOOM, show a negative influence of these herbicides. This one is translated by the variability of carbon mineralization, which is explained by the reduction of rates of the organic carbon mineralization in presence of Topic and a depressive effect of ZOOM on the coefficients of mineralization. It should be noted that if the Topic would be slightly stimulated the production of CO2 especially under the effect of the double dose, ZOOM meanwhile, has had a negative influence on the production of mineral carbon. It would suggest that the mobility of topic, once it is weakly adsorbed into the two soils, can contribute to the pollution of groundwater by leaching of chemical molecules. This phenomenon can be avoided by the contribution of fresh organic materials capable of binding metabolites. ZOOM, which is strongly adsorbed into the two soils, inhibits the activity of microorganisms.

It would be by consequence interesting to use Topic with simple or double dose, especially texture clay soils whose the complex clay-humic contributes to the good management of mechanism of the organic materials mineralization. As it is advised to not use the herbicide ZOOM especially in sandy soils, where its toxic effect is so strong, otherwise, it should imperatively enrich the organic material soils so as to reduce the negative impact of herbicides.

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