

RESEARCH ARTICLE

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Impact of Herbicides upon dynamic of the nitrogen in SoilsR. Cheloufi¹, A. Zouaoui^{2*}, H. Messaadia³¹Magister, u d'El Tarf.²Maitre de conférences A, u. Batna.³Maitre de conférences B, responsable de laboratoire de biologie des sols, u. Batna.**Abstract**

The results focus on the variable influence of two herbicides Topic and ZOOM, on the organic nitrogen mineralization in two types of soils, clay-sandy and sandy. It was noted that the effects of the herbicide Topic are generally positive on nitrogen mineralization, whatever the type of soils. It is advisable or even necessary to make contributions of fresh organic matter that promotes on one hand, stimulation of the microflora and allow in other part the reorganization of humic elements avoiding leaching and groundwater pollution.

Key words: herbicides ZOOM and Topic, microfiores, mineralization of nitrogen, soils

1. Introduction

The amelioration of agricultural production to satisfy the nutritional needs of populations' requires as a pre-intensification of agricultural and the use of fertilizers to compensate the nutritional deficiencies of plants and plants products to limit the proliferation of predators. However, the herbicides in a conservative farming and protecting soils against the erosion can it ameliorate the rate of the organic material and the retention's capacity of the soil's moisture?

These pesticides have been work focused either on their dynamics on soils as mineralization [6, 4, 12]; the absorption and desorption of molecules [25, 17, 16, 8]; or again the effects on soils' properties [18]; [14]. Biologically active, they represent a potential risk of toxicity for wildlife and environment (1). Studies have shown changes in the soil's biomass because of pollutions (heavy metals, hydrocarbons, pesticides,...) (Harden and al.; 1993; in [24], and herbicides affect the diversity of bacterial microflora (Martin L. et al, 2006 in [5]). The same application of fungicides, insecticides and all biocidal treatments.

The study of herbicides' influence on organic materials' mineralization in soils has done the objective of numerous investigations with impacts such us soil pollution [2], ecotoxicity of xenobiotic substances towards soils' microflora [26], the interactive role of earthworm macrofona in the dynamic of herbicides in cultivated temperate soils [14], the effect of these products of fist and second generation on biochemical properties and microbiological soil [17], and comparative and

interactive effects of pesticides and physical factors on the mineralization of carbon substrates in soil [12].

The effect of herbicides of type Topic and ZOOM has been studied in a various setting. These compounds can they have similar effects in soils of the wetland in Algeria. However, knowing that they constitute the main limiting factor of crop production, and a major element in plant's nutrition [19], in which they determine the root development, while promoting optimal absorption of other nutrients in the soil [9]. In small amounts the nitrogen can limit the decomposition, whereas only optimal doses it stimulates the growth and productivity of crops [20]. The nitrogen is the nutrient of all, the one that is difficult to manage fertilizers [21]. More specifically, these products can they decompose the microbial action and release additional quantities of nitrogen to improve nitrogen nutrition of plants or on the contrary will they inhibit the biological activity, thus contributing to reduce the amount of nitrogen in soils?

Thus, our study aims to understand the effects of these herbicides (Topic and ZOOM) on the activity and functioning of terrestrial microflora on the evolution of mineral nitrogen and on the evolution of the coefficient of organic nitrogen's mineralization in two representative types of soils of the area of Ben M'hidi (El Taref- Algeria), especially knowing that the nitrogen in the soil occurs mainly on organic form and must be mineralized by the microorganisms of soil I, order to become the more available to plants during growth.

The choice of soils on the basis of their structural/textural features (clay-sandy and sandy) can

teach us about the effect of micropores that protect the organic material as well as on the rate of nitrogen mineralization that are higher in clay soils compared with sandy soils (Simara and al; in [19]).

2. Material

2.1-Soils Sampling

Sampling on a depth of 30cm of two soil samples. They are distinguished by their texture, one is dominant clay (case of soils of region Sidi M'barek) and the other is dominant (case of region of Ghourd El Bourk).

2.2- Choice and Characterization of Herbicides

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

-Topic 080 EC: it is used against weeds (wild oat ray grasse) 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: (C₁₇H₁₃ClFNO₄), and 20 g/l Cloquintocet-mexyl: (C₁₈H₂₂ClNO₃).

-ZOOM, its fast effect is followed by leaves destruction and roots of weeds. Chemically, the ZOOM has the following composition: triasulfuron (4, 1%): C₁₄H₁₆ClN₅O₅S and Dicamba

(65, 9%): (C₈H₆Cl₂O₃).

Indices H and D reported in the tables and figures denote respectively the herbicide Topic and herbicide ZOOM. While indices D1 and D2 indicate the dose 1 and dose 2.

3. Methodes

3.1- Analytical Study of Soil Samples

The analytical study of soil samples focuses on: particle size, water-holding capacity, the cation exchange capacity; pH and; total limestone; total organic carbon; organic matter; total nitrogen and phosphorus.

3.2- Experimental Device

3.2.1- Study of the Evolution of Mineral Nitrogen in the Soil

- *Mineralization Method*: characterization of interactions between microbial groups, herbicide and soils has been conducted by incubating the soils in

pots in laboratory. The monitoring of nitrogen mineralization was performed according to kinetics of 60 days.

- *Preparation of Soils for the Incubation*: in order to not affect their potential microbiological, soil's samples (25g) were stored to 4°C, and then they were taken and mixed with the herbicide. Next, they were placed inside the sealed vials under moisture equivalent to 2/3 of the holding capacity, and then placed in incubation at a constant temperature (25g), during a period of 60 days.

- *Designs of the Incubation and Measurements of Microbial Activity and Mineral Nitrogen*: Samples of 1 kg of dry soil were incubated under constant temperature of 25 °C during 60 days and each treatment resulted 3 repetitions. The kinetics of mineralization is followed during this period according to steps of: 0, 3, 7, 11, 14, 21, 28, 42,60j. each kinetically, we collected a sample of 12 g of soil for analysis and dosage of NH₄ and NO₃ and this in different treatments: only soils soil herbicides.

3.2.2- Application Rates of Herbicides

Different doses' application of herbicides used (Table 1) were defined according to the agronomic standards practiced by farmers.

Table 1: Doses of both herbicides used in the experiment

<i>Expérimentations 01 (25 g) la minéralisation C.</i>			
Topic (h1)		ZOOM (h2)	
Doses (ul)		Dose (ug)	
166,4	332,88	100	200

3.2.3- Determination of Mineral Nitrogen

The determination of mineral nitrogen was performed according to the method and Drouineau and Gouny, in [3]. Taking of aliquot of 20 ml of the filtered solution to which we add 20 ml of NAOH 6N. The distilled ammonium is trapped by boric acid (2%) in the presence of an indicator (reagent tachiro) then, titrated with a solution of sulphuric acid (0.05 N). Nitric nitrogen is determined on the same sample by adding the distillation flask a pinch alloy DIWARDA reducing nitrate (NO₃⁻) from the soil into ammonia nitrogen (NH₄⁺). We proceed to a second distillation in the same conditions. The distilled nitrogen NH₄⁺ actually represents the nitric nitrogen NO₃ of soil.

3.3-Expression of the Results of Nitrogen Mineralization in Soils

The study of nitrogen mineralization and its intensity requires the use of different indices of mineralization:

i- Coefficient of Nitrogen Mineralization is determined as follows:

$$*- \text{CM of system soil (\%)} = N_{\min} \cdot 100 / N_{\text{org}}$$

$$*- \text{CM of herbicide (\%)} = (N_{\min} (\text{soil+herbicide}) \cdot 100 / N_{\text{org}} (\text{soil+herbicide})) -$$

$$N_{\min} (\text{soil}) \cdot 100 / N_{\text{org}} (\text{soil}) - N_{\text{org}} (\text{soil})$$

ii- Rate of Inhibition or Stimulation of Herbicides: The formula for the evaluation of percent inhibition or stimulation of a given treatment to the control data is:

$$\% \text{ Inhibition (stimulation)} = 1 - \% \text{ degradation treatment} / \% \text{ degradation of witness}$$

3.4-Methods of Data Treatment

Data were treated by two methods: the analysis of variance (ANOVA), as well as method of correlation in simple regression using the Minitab 13 (D).

The experimental plan in a bloc totally random, corresponds to a factorial system 5x2 (5 treatments and 2 soils), with 3 repetitions and 7 dates.

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

<i>Physico-chemical properties</i>	<i>soil1 (Ghourd el bourk)</i>	<i>soil 2 (Sidi m'barek)</i>
Size %	clay silt sand 36 20 44	clay silt Sand 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) NO ₃ (ppm)	5,3
		15
N org (ppm)	235	360
C (%)	1,92	0,4
MO (%)	3,30	0,69
C/N	14,76	10

4.2.-Effect of Herbicides on the Mineral Nitrogen Mineralization

-Effect of Herbicides on the Evolution of Ammonia Nitrogen: In sandy soil (S2), Topic (D1

4. Interpretation of Results

4.1-Interpretation of Analytical Data

According to the physico-chemical results, (table 2) the soil of Gourd election Bourk is of a texture clay-sandy, mildly alkaline electric to electric conductivity and of very low calcium content. Holding capacity is somewhat high. The cation exchange capacity is of 70 meq/100 g of soil. With organic carbon content of 1.92%, a relatively high organic matter rate (3.30%), our soil is rich in humus. Because of the nitrogen content and a ratio C / N of 14.76 biological activity is somewhat average limiting the evolution of organic matter into humus, or slowing its mineralization. These results such cases the soils are either poorly structured or asphyxiant [9]. In the alkaline soil of Sidi M'Barek (Table 2) the texture is sandy. The electrical conductivity is very low. Limescale. Very low retention capacity and cation exchange capacity of 19 meq/100 g of soil. Low to very low values for carbon, organic matter and nitrogen. The C / N ratio is equal to 10.

and D2) positively affects organisms, while ZOOM has a toxic effect (figure1).

By stimulating the activity of microflora, Topic acts as nutrient substrate. This beneficial effect is probably due to the fact that the microflora uses herbicide as a nitrogen source. For Grossbard, (1976);

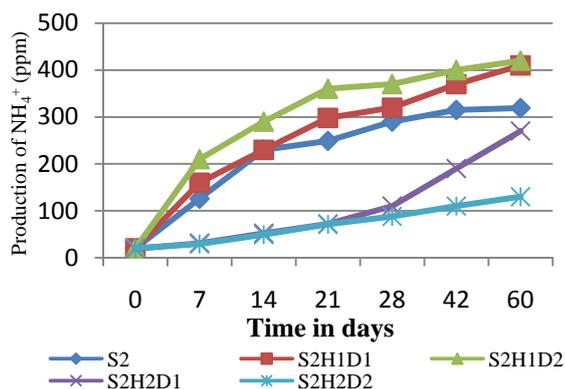


Figure 1: Influence of Topic (H1) and ZOOM (H2) on the evolution of ammonia nitrogen in soil2 (doses D1 and D2)

in [26], this effect is due to the fact that ammonification is less sensitive to biocides.

Table 3- stimulation of herbicides on nitrogen mineralization in soils

herbicide	traitements	S1H1d1	S1H1d2	S2H1d1	S2H1d2
(H1) Topic	stimulation au 60°j	101 %	105 %	128 %	131 %
herbicide	traitements	S1H2d1	S1H2d2	S2H2d1	S2H2d2
(H2) ZOOM	inhibition au 60° j	39 %	50 %	16 %	60 %

-Effect of Herbicides on the Evolution of Mineral Nitrogen: As in clay soil (S1) (figure 2), the effect of the herbicide ZOOM in sandy soil is more toxic, as it is also depressive on organic nitrogen mineralization.

This resulted by an increase of rate of inhibition coupled with the dose, followed of a decline of ammonificatrices and nitrificatrices activities. This decrease of microbial activity recalls the effect of trifluralin towards the nitrification and nitrogen fixation [13, 7].

Regarding Topic, the statistical study highlights the existence of very significant difference between systems soil-witness / soil-herbicide, thus confirming the positive influence of Topic, an effect that seems to vary with dose and in which the increase stimulates the activity of mineralizing germs of nitrogen. This stimulation shows that Topic can be used as a source of nitrogen for the nutrition of micro-organisms, and for plant growth.

- Influence of Type of Herbicide on the Evolution of Organic Nitrogen Mineralization: The herbicide ZOOM (H2) is characterized by a depressive effect accentuated and toxic towards microflora (figure 3). This is due to its action of inhibition of some functions of microbial biomass.

The biggest observed quantities D1, confirm an effect Topic (H1) less accentuated, probably due to its use as nitrogen source by micro-organisms.

According to [18], the unfavourable effect of ZOOM is due to the toxic effect of xenobiotics products that result eventually from its biodegradation. During the kinetic, the depressive effect causes the fall of a quantity of ammoniacal nitrogen due to the nitrification of a portion of ammoniacal nitrogen is to a microbial reorganization of this nitrogen [8].

In addition, the negative effect of ZOOM is probably due to aerobic nitrification, mechanism key that occurs in the soil horizon, where pesticides are concentrated.

The results of the statistical study (table 3), allow to establish that: i) for Topic, a positive influence that results by a stimulation of the activity of microorganisms, and ii) for ZOOM, the decrease of the speed of mineralization explained by a negative influence and a toxic effect against microflora.

-Effect of Dose of Herbicide on the Evolution of Organic Nitrogen Mineralization: In sandy soil (S2), if the effect of the herbicide Topic (H1) to D1 is unchallenging whatever its dose, it releases in contrast in clay soil, with important doses of mineral nitrogen in which the increase induces a stimulatory effect (figure 4).

It is possible that the concentration of a pesticide in the environment can affect kinetic of degradation while being directly proportional to the concentration till certain value, but independent beyond.

The inhibitory effect of the herbicide ZOOM as seen (figure 5) is therefore related to the increase of dose. By increasing the dose, the inhibition becomes more important.

4.3-Influence of Herbicides on the Intensity of Organic Nitrogen Mineralization

-Effect of Herbicides on the Evolution of Coefficients of Nitrogen Mineralization: The effect in clay sandy soils of herbicide Topic (D1 or D2) (figure 6), is negative on the rate of mineralization. The coefficient of mineralization intensity is inversely proportional to the dose (figure 8). Herbicide

application with a strong dose is susceptible to reduce the activity of microbial biomass.

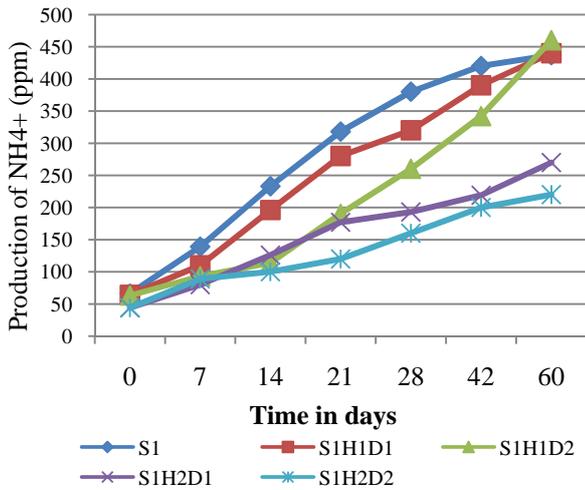


Figure 2: Influence of Topic (H1) and ZOOM (H2) on the evolution of mineral nitrogen in soil S1 (doses D1 and D2)

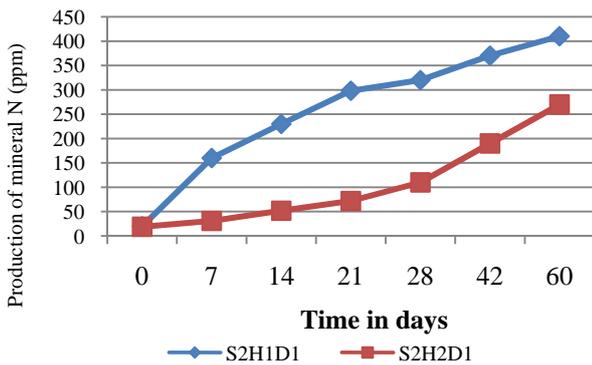


Figure 3: Influence of herbicide Topic (H1) and ZOOM (H2) on the evolution of mineral nitrogen in soil S2 (dose D1)

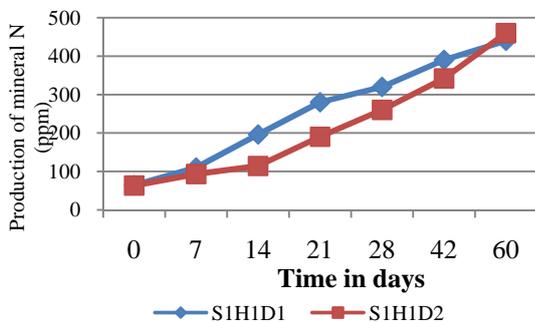


Figure 4: Influence of doses (D1 and D2) the herbicide Topic (H1) on the evolution of mineral nitrogen in soil (S1)

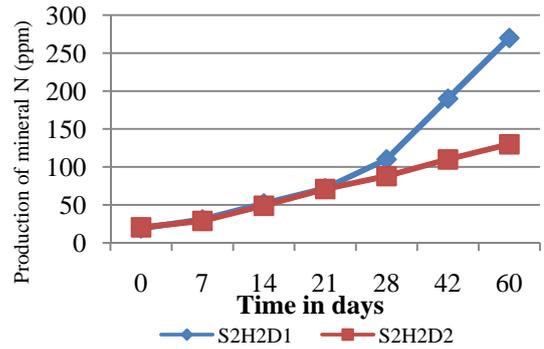


Figure 5: Influence of doses (D1 and D2) the herbicide ZOOM (H2) on the evolution of mineral nitrogen in soil (S2)

When herbicide ZOOM has a simple dose, its effect on the coefficient of mineralization is very important. A D1 and D2, is toxic towards microbial strains. Its effects of metabolism modification and of its inhibitory action of enzymatic activity in soils, induce coefficients of mineralization in system soil 1/herbicide 1 (D1 and D2), much more week in system witness (figure 7). From [1], when levels in herbicide in the solution of soil are too high, it happens that the active material is not be degraded, especially toxic molecules that denature enzymes or degrader micro-organisms. Concerning the evolution of ZOOM, coefficients of mineralization (D1 and D2), are characterized by rates relatively week (figure 9).

Comparatively to the week effect of Topic, obtained to dose D2, a D1 and D2, the coefficient of nitrogen mineralization is relatively high (figure 6). The obtained coefficient in system soil/herbicide to dose 1 is relatively higher in all treatments (figure 8). It is possible that the degradation of herbicides would be very important in light textured soils where clay colloids and humus are in very small quantity.

From figure 7, the effect dose herbicide on the coefficient of mineralization is negative in comparison to witness. This is explained by its texture towards nitrogen mineralizing germs. ZOOM almost plays a role of biocide (antibacterial). In this context, bacteria degrade the herbicidal molecule, neutralize it and turn it into more or less stable metabolites causing according to [20], the decline of biomass. Our results highlight an important degradation of organic N in sandy soil than in clay soil. Concerning the intensity of mineralization, the coefficients of ZOOM

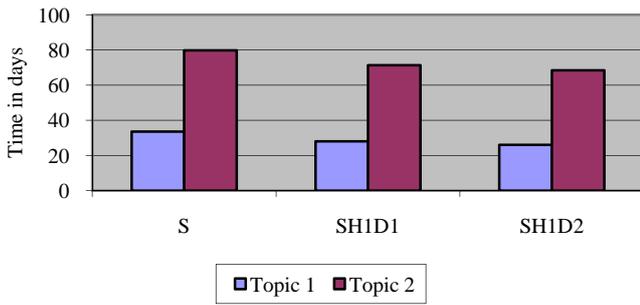


Figure 6: Evolution of coefficients of mineralization of organic nitrogen in soil and system soil Topic 1-Topic 2

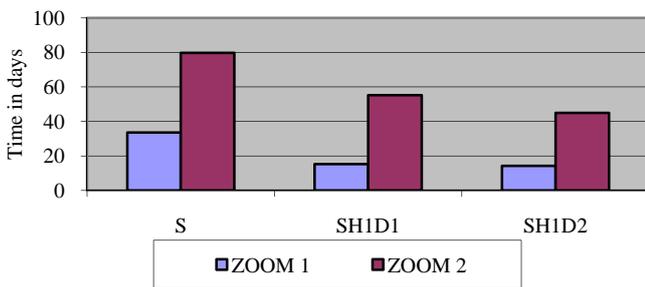


Figure 7: Evolution of coefficients of mineralization of organic nitrogen in soil and system soil ZOOM 1-ZOOM 2

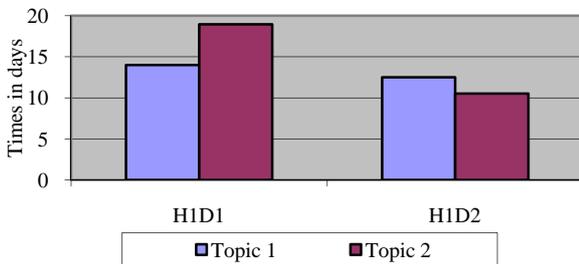


Figure 8: Evolution of coefficients of mineralization of herbicide Topic 1 and Topic 2 in soil

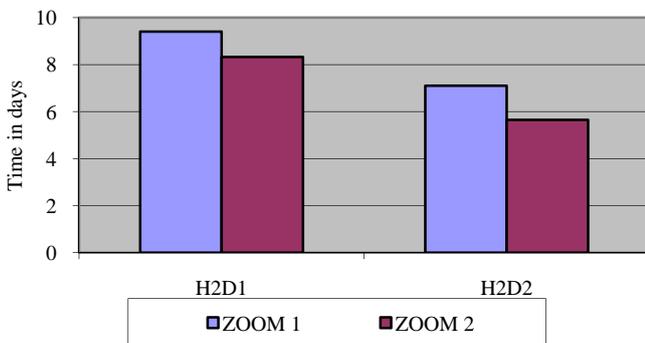


Figure 9: Evolution of coefficients of mineralization of herbicide ZOOM 1 and ZOOM 2 in soil

mineralization in this type of soil, emphasizes a depressive effect (figure 9). The mineralization is faster in light textured soils than heavy soils, in which grain fraction form with organic substances organo-mineral complexes difficultly degradable by microbial cells. According to Zin and al, (2005) in [27], clay minerals protect the organic material of soil of degradation by micro-organisms. For [10], microbial cells adhering strongly to clay aggregates.

5. Conclusion

Our study highlights a marked variability of organic nitrogen mineralization by two herbicides Topic and ZOOM in the different used treatments.

In sandy soils, less depressive Topic, with double dose, acts as a nutrient substrate, probably due to its use as a source of nitrogen by microorganisms that allow a better stimulation of microflora. In this type of light-textured soil, where colloids of clay and humus are found in very week quantity Allen and al 1987, believe that the degradation of herbicides is more important.

- Effect of Herbicides on the Evolution of Coefficients of Nitrogen Mineralization in Sandy Soil:

This explains the existence of a coefficient of organic nitrogen mineralization that is relatively high. Unlike herbicide Topic, the herbicide ZOOM, especially with double dose, is more depressed on the organic nitrogen mineralization and its toxic effect towards the nitrifying bacteria affects their ammonifacrice and nitrificatrice activity in both types of sandy soils and clay soils.

Roger and al, (2001) attributes these differences of the evolution of nitric nitrogen quantity to the nature of nitrogen compounds and to structural/textural type of soil. Al Rajab, (2007), believes that when the amounts of herbicide in the solution of soil are too high, it happens that the active substance is not degraded.

Thus, the fact that the herbicide Topic releases especially in clay soil, large doses of mineral nitrogen and in which the increase induces a stimulatory effect can, for this purpose, be used as a source of nitrogen for the nutrition of microorganisms and for the growth of plants.

We should notice, however, that with the mobility of Topic, and the fact that it is less absorbed by the ground, it is to considere a pollutant effect of groundwater. And also to prevent the leaching of chemical compounds due to pollution, it would be interesting to bring fresh organic matters.

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