The Effect of Some Earthworm Casts Species Collected in Algeria on the Plant Growth

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Abstract

Researches encourage the introduction of earthworms in order to improve productivity and addressing degraded soils. Our study focuses on the effect of 6 earthworm species on soil fertility. In this objective, a growth test is performed at laboratory to observe the growth of wheat plants (*Triticum turgidum* L.) in culture media consisting of sand and excrement of different earthworm species collected in Algeria: *Aporrectodea rosea (Savigny, 1826), Octodrilus complanatus* (Dugès, 1828), *Aporrectodea trapezoides* (Dugès, 1828), *Allolobophora molleri* (Rosa, 1889), *Eisenia fetida* (Savigny, 1826), *Microscolex phosphoreus* (Dugès, 1837). The results between species are not significant for both growth and dry matter parameters. However, averages are best in substrates of both species *Eisenia fetida* (growth: 31.89 ± 2.22 cm, dry matter: 73.59 ± 5.39) and *Octodrilus complanatus* (growth: 31.28 ± 0.79, dry matter: 76.03 ± 2.13).

KEYWORDS: Earthworms species, soil biology, soil fertility, worm castings.

INTRODUCTION

Earthworms are indicators of soil quality. They are very useful in agriculture. Also, they are essential for soil fertility, sustainability and growth of the plant. The introduction of earthworms in desert soils in Tajikistan (Temirov and Valiakhemedov, 1988), forest plantations in the Caspian region (Vsevolodova Perel and Sizemskaya, 1990), grasslands and desert areas (Brun, 1987) confirm the possibility of large scale use of earthworms for soil remediation. They confirm the possibility of using earthworms to soil remediation. For example, the introduction of the species *Aporrectodea caliginosa* in coniferous forests in Finland brings positive results (Huhta, 1979).

Chevalier *et al.,* (2001) reports that Scotland pasture land, improved after the introduction of earthworms. A report carried out in New Zealand on the effects of earthworms on pasture productivity, indicates a 70% increase in the spring production of grassland after four years, which later was 30% more than non-inoculated fields. Also, infiltration rates were doubled and soil moisture increased by 17%.

Studies on the relationship of earthworms and soil show many variable results, which are probably related to differences in species, the levels of nutrients in earthworm's excrement and soil type.

The objective of this subject is to study the relationship of soil fertility - earthworm species. For this, we conducted a test on growth of wheat plants (*Triticum aestivum*) in substrates enriched with feces of different earthworm species.

MATERIALS AND METHODS

Sampling of soil and earthworms

Earthworms and their droppings are collected during the months of February and March 2013 in eight stations (Table 1). The soil is removed from the layer that contains the most earthworm castings (on a surface of 1 m^2 and 0-20 cm deep).

Table 1. Characteristics of sampling stations

Station	Geographical coordinates	Vegetation type	Erathworm species	Family species	Ecological category
Hamma Bouziane	36°24'38.87" N 6°35'28.08"E	herbaceous vegetation	*Octodrilus complanatus* (Dugès, 1828)	*Lumbricidae*	*Anecic*
Daksi (Constantine)	36°21'20.15" N 6°38'40.85"E	herbaceous vegetation	*Aporrectodea rosea (Savigny, 1826)*	*Lumbricidae*	*Endogeic*
Salah Bey	36°22'57.93" N 6°34'30.46"E	herbaceous vegetation, beside a river	*Allolobophora molleri* (Rosa, 1889)	*Lumbricidae*	*Endogeic*
Bouira	36°12'59.56" N 4°03'26.40"E	herbaceous vegetation	*Aporrectodea trapezoides* (Dugès, 1828)	*Lumbricidae*	Endo-anécic
Oued El Athmania	36°12'08.82" N 6°15'27.18"E	herbaceous vegetation	*Eisenia fetida* (Savigny, 1826)	*Lumbricidae*	*Epigeic*
Tassadane (Mila)	36°16'33.50" N 6°10'39.86"E	herbaceous vegetation	*Microscolex phosphoreus* (Dugès, 1837)	*Megascolecidae*	*Epi-endogeic*

Analysis of some chemical parameters

We measured 6 soil parameters for each culture medium. pH, electric conductivity (EC), organic matter (MO%), total nitrogen (% N), available phosphorus (P_20_5 in ppm) and the available potassium (K_2O%) according to AOAC (1980).

The growth test

a) Cleaning of the sand. The sand is taken from the beach of Sidi Abdel Aziz (36° 53'27.11 " east latitude and 006° 08'39.17 " north longitudes). It is washed with HCl (0.1 N) and then rinsed several times with distilled water and dried in an oven at 105 °C for 24 h.

b) Experimentation and plant material used. After preparing three culture media (containing sand and earthworms excrement) for each station, which corresponds to earthworm species, with 3 control pots (with only Sable). We are sowing 5 seeds of wheat (*Triticum aestivum*) in each culture media (or 3 x 7 = 21 culture media).

c) The monitoring of the experiment. The test is carried out under homogeneous conditions controlled. Watering was effected only with distilled water.

d) Measured parameters. we felt the two variable height growth and total dry matter, after 7 weeks of sowing date (04/21/2013).

e) Data processing. The results are processed by the XLSTAT 2014 software.

RESULTS

Soil characteristics of culture media

The average pH of the culture media (Figure 1) ranges from 5.9 ± 0.03 (*E. fetida*) to 7.21 ± 0.09 (*Oct. complanatus*). The values decline with the feces of species (*E. fetida*, *Al. molleri*, *Ap. trapezoids Ap. rosea* and *Mx. phosphoreus*) compared to the control soil (pH 6.82 ± 0.14). However the pH of *Oct. complanatus* soil increases slightly (7.21 ± 0.09). The first observation is due to intestinal secretions substances that characterize the earthworm excrement; which increases soil acidity. For the second finding, high pH values are probably related to soil from the *Oct. complanatus* species, which is rich in $CaCO_3$ (Bazri, 2013b).

The electrical conductivity values are higher in soil of *E. fetida*, *Ap. rosea*, *Mx. phosphorous* and *Oct. complanatus* species (Figure 2). These results are due to a high ionic concentration, such as nitrate ions (NO^-_3) (El Oumri & Vieillefon, 1983).

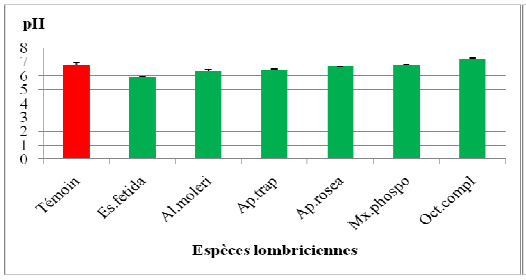


Figure 1. pH of the culture media

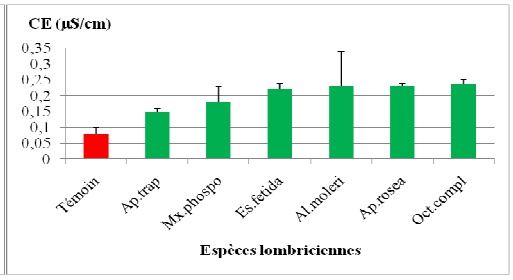


Figure 2. CE (µS/cm) of the culture media

The average of the organic matter are considered very low in all culture media (Figure 3), they vary from (0.25 ± 0.07%) and (0.9 ± 0.13), but the values remain elevated in the soil of the *E. fetida* species. The sample of the latter is taken from a very rich plant organic matter. Frankle (2005), Steven *et al.* (2009) noticed that organic matter decreases in soil containing earthworms. It reached values between 35.2 and 42.3%.

The nitrogen content is high in all soil samples for all earthworm species (Figure 4). These results were confirmed by Bohlen *et al.* (2004), who indicates that the nitrogen concentration is very important in the earthworm's casts. Nibras (2011) found levels up to 0.89%.

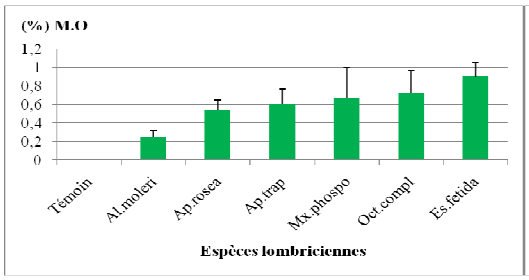


Figure 3. M.O (%) of the culture media

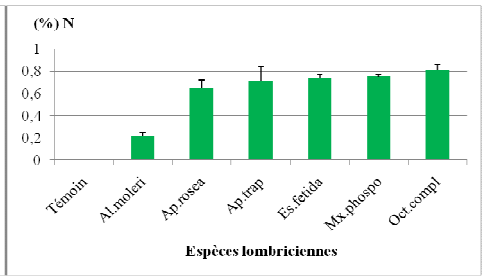
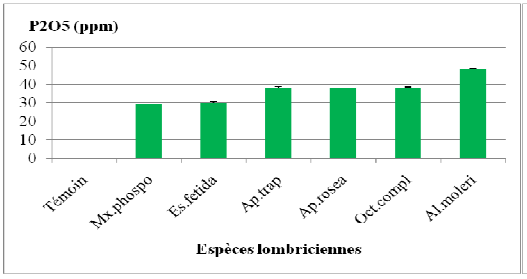


Figure 4. N (%)of the culture media

The averages of total phosphorus are high in all samples (Figure 5). They change from 29 ± 0.34 ppm (*Mx. phosphorus*) to 48 ± 0.33 ppm (*Al. moleri*). Our results are

similar to those of Nibras (2011) who recorded 0.47 ppm in soil frequented by earthworms. Bohlen *et al.* (2004b), report that the species *Polypheretima elongate* increases the total phosphorus content in the soil of 50%, compared to soils without earthworms.

The available potassium levels are high (Figure 6). They range from 0.6 ± 0.01% (*E. Fetida*) to 0.9 ± 0.04% (*Mx. Phosphoreus*). Nibras (2011) noticed that the potassium values may reach 97% in soils containing earthworms.



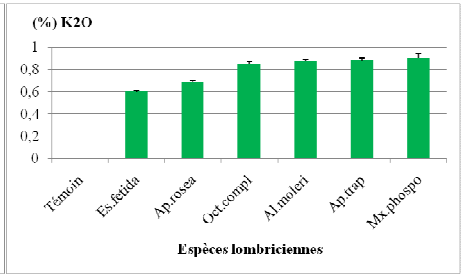


Figure 5. P_2O_5(ppm) of the culture media **Figure 6.** K_2O(%) of the culture edia

Relationship earthworm species - soil fertility

Plant growth. Although the test reveals the role of earthworms in soil fertility. The growth of wheat plants is higher in the substrates, enriched by excrement of earthworms compared to the control substrate consists only of sand (Figure 7).

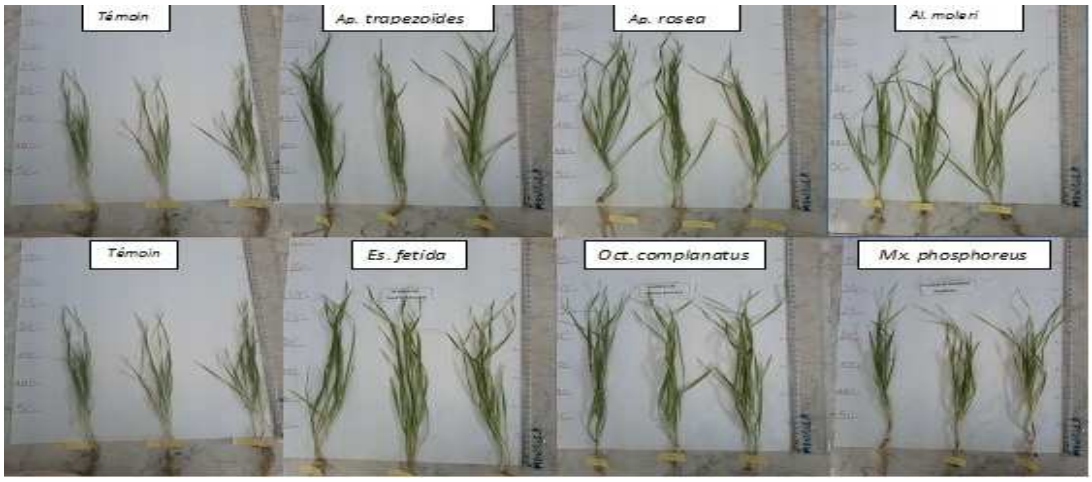


Figure 7. The growth of wheat plants in culture media

From Figure 8, the mean values ranged from 29.56 ± 0.92 (*Al. Molleri*) to 31.84 ± 2.22 (E. *fetida*). The multivariate analysis of variance test did not show significant differences in growth between species. Nevertheless, growth values appear slightly higher in *Eisenia fetida* (31.89 ± 2.22 cm), *Octodrilus complanatus* (31.28 ± 0.79) and *Microscolex phosphoreus* (30.80 ± 0.95).

The dry matter (MS): The dry matter averages oscillate of 69.31 ± 0.89% (*Al. molleri*) and 76.03 ± 2.13% (*Oct. complanatus*). The multivariate analysis of variance test is not significant, but the values are better in excrement of taxa *Octodrilus complanatus* (76.03 ± 2.13) and *Eisenia fetida* (73.59 ± 5.39) (Figure 9).

The dendrogram of hierarchical clustering (AHC) reveals three classes grouped according to the proximity matrix (Fiigure. 10). The first includes three species *Ap.*

rosea, *Ap. trapezoids* and *Oct. complanatus* with a similarity level of 99.98%; the second includes *E. fetida* and *Mx. phosphoreus* with a similarity level of 99.95% and the third class is linked to *Al. molleri*. to *Al. molleri*.

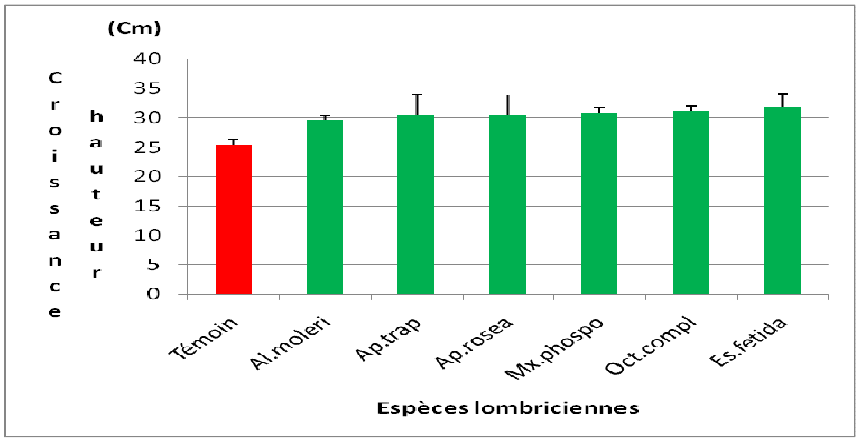


Figure 8. The growth of wheat plants in soil enriched with earthworm excrement of different species.

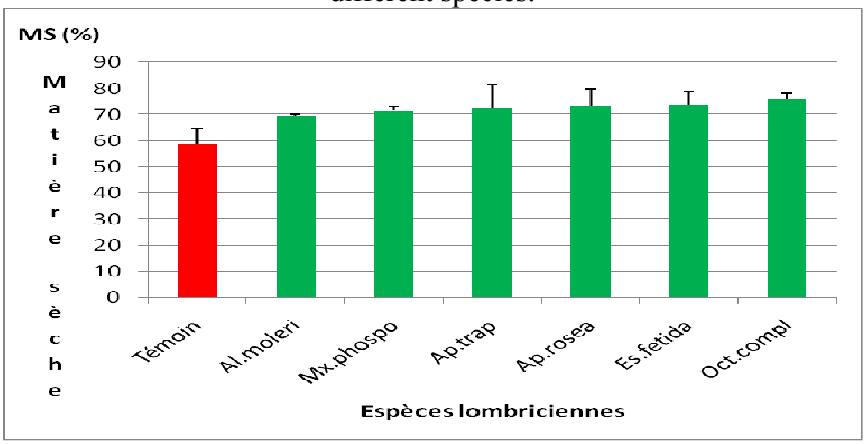


Figure 9. The total dry matter of the wheat plants in soil enriched with earthworm excrement of different species.

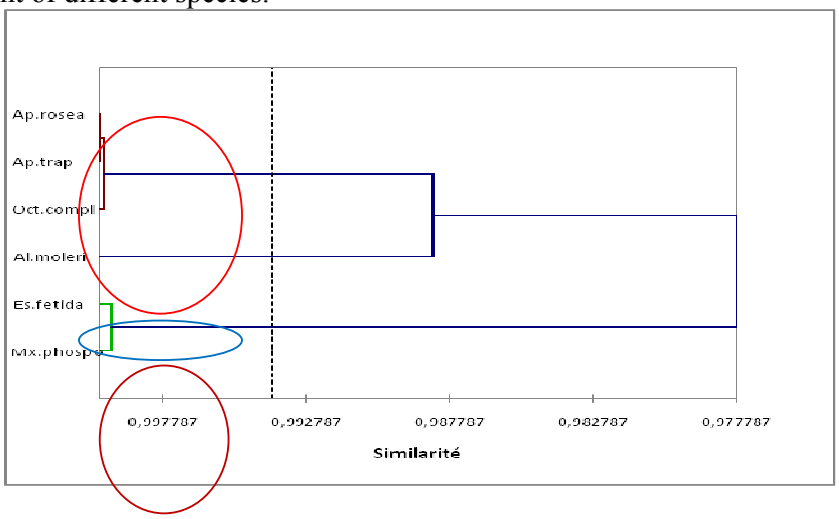


Figure 10. Dendrogram of different earthworm species classes

In addition, correspondence factorial analysis (CFA) (figure 11) shows that the species *E. fetida* is correlated with % M.O; *Mx. Phosphoreux* excrements are rich in % N. However, *Al. molleri* species leans toward the high contents of P_2O_5 (ppm).

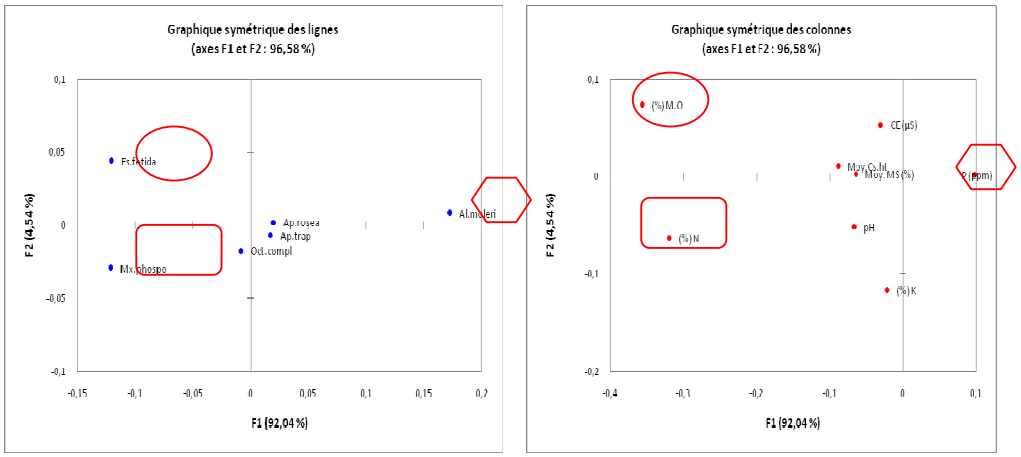


Figure 11. Results of the CFA, between earthworm species and soil parameters

DISCUSSION

Studies on the excrement earthworm's compositions show their richness in nutritive element (Barois, 1992). Lunt and Jacobson (1944), note that earthworm casts are rich in N, P, K, Ca and Mg. This is the case of our test that also shows a variability of nutrient content in these materials. The differences may be related to habitat types and the worm's food. The lack of data and literature on this topic is a barrier to compare our results.

The growth test is positive in soil enriched with earthworm excrement. These results are also due to substances (vitamins, plant hormones, enzymes and amino acids) detected in extracts of earthworms (Gavrilov, 1962; Nielsen, 1965; Graff and Makeschin, 1980; Dell'Agnola *et al.,* 1981). Springett and Syers (1979) note that similar substances to auxin are present in the manure. Microbial derived plant hormones have also been isolated from the earthworm waste (Tomati *et al.,* 1988).

The species studied on this subject (the effects of earthworms on plant growth) are limited (Lee, 1992). While the range of material existing for study and research is enormous; whereas there are about 4000 earthworm species identified.

In general, positive effects are also reported more frequently in soil's earthworm whether in pots or in fields with the *Aporrectodea*, *Eisenia*, *Allolobophora* and *Lumbricus* species (Puttarudiah and Sastry 1961; Rose and Wood, 1980).

In our case, earthworm's feces particularly those of *Octodrilus complanatus*, *Eisenia fetida*, *Microscolex phosphoreus*, *Aporrectodea trapezoids* and *Aporrectodea rosea* seem interesting in the remediation and soil fertility.

In the Algerian soil, Bazri (2013a) encourages the use of both species *Aporrectodea trapezoides* and *Aporrectodea rosea*, dominant and well adapted to the Algerian climate (species present from the coast to the desert).

CONCLUSION

Earthworm excrements of *Octodrilus complanatus*, *Eisenia fetida*, *Microscolex phosphoreus*, *Aporrectodea trapezoides*, *Aporrectodea rosea* and *Allolobophora molleri* show positive results for plant growth. The effect of the earthworms

excrement used in our test does not exhibit significant differences. However, there are differences between their nutrient content.

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