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I J N R E

Soil amendment by olive pomace improving soil quality

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Résumé:

La majorité des déchets agricoles, y compris les déchets de l'extraction d'huile d'olive, sont utilisés comme amendements du sol en raison de leur haute valeur nutritionnelle. L'objectif de cette étude était d'examiner les effets de l'amendement avec des grignons d'olive provenant d'un système triphasé pressé à froid sur les caractéristiques de fertilité du sol pH, conductivité électrique (CE), et matière organique (MO). L'expérience a été réalisée en utilisant deux taux croissants de grignons d'olive (50% et 100% v/v) plus le sol témoin non traité dans des microcosmes dans des conditions de laboratoire. Les résultats ont montré que le 50% de grignons d'olive a légèrement réduit le pH du sol et légèrement augmenté sur la (CE) du sol tandis que le 100% de grignons d'olive a une diminution significative sur le pH du sol et une augmentation significative dans la (CE) du sol, En outre, l'amendement du sol avec des grignons d'olive a augmenté de manière significative la matière organique du sol. en conséquence, nous pouvons considérer les grignons d'olive comme un engrais pour le sol. Il est également recommandé de prétraiter les grignons d'olive pour réduire son pH acide et la teneur en sel avant de les utiliser comme amendement du sol.

Mots clés : Grignons d'olive, Sol, Amendement, Matière organique, Qualité.

Abstract:

The majority of agricultural wastes, including olive oil mill waste, are used as soil amendments due to their high nutritional value. The purpose of this study was to investigate the effects of the amendment with olive mill pomace from a 3-phase cold-pressed system on the characteristics fertility of the soil pH, electrical conductivity (EC), and organic matter (OM). The experiment was carried out using two increasing rates of olive mill pomace (50% and 100% w/w) plus the control untreated soil in microcosms under laboratory conditions. the results showed that the 50% of olive mill pomace was slightly reduced soil pH and slightly increased on soil (EC), while the 100% of olive mill pomace has a significant decrease on soil pH and a significant increase in soil (EC), Moreover, the amendment of the soil with olive mill pomace has significantly increasing soil organic matter. As a result, we can consider the olive mill pomace as a soil fertilizer. Pretreatment of olive mill pomace to reduce acidic pH and salt content before use as a soil amendment is also recommended.

Keywords: Olive mill pomace, Soil, Amendment, Organic matter, Quality.

1. Introduction

From antiquity to the present, the olive industry is among the most traditional crop production, with important productive relevance for Mediterranean countries. Algeria is the ninth country producing olive oil in the world, about 4% of global production [1]. Several procedures can be used to extract olive oil, including the 3-phase extraction processes described in this study was generated two types of effluents liquid effluent olive mill wastewater (OMWW) and a solid residue olive mill pomace (OMP) evaluated in this work. Due to the huge amount generated of these effluents in a short period of time and they generally characterized by acidic pH, high level of salinity, and high organic matter content (OM), they represent a possible risk to the environment [2, 3].

The amendment of the agricultural soil by olive mill pomace has seemed to be operationally uncomplicated and economically achievable. Several researchers have focused on the use of raw or composted pomace on agricultural land for a short or long time [4, 5, 6], found that, due to its high amounts of minerals required for plant growth and development, such as potassium (K), nitrogen (N), phosphorous (P), magnesium (Mg), and organic matter, the olive mill pomace can be accepted as an effective fertilizer.

Moreover, organic matter is present in low quantities in most Mediterranean agricultural soils which are a limiting factor for plant growth and production. For example, in, Tunisia due to the lack of organic matter in soils and the aridity climate, the authorities have decided to utilize OMW as soil organic fertilizers in the agriculture sector (Decree 1306 of February 26, 2013) [7].

In this context, the study of the amendment of olive mill pomace on the characteristics fertility of the soil is necessary to improve soil quality in the Mediterranean countries and ensure plant growth without negative effects on the soil.

This work aims to investigate the effect of the amendment with olive mill pomace at two different rates (50% and 100% w:w) corresponding to doses allowed by law on the soil pH, electrical conductivity (EC), and the organic matter (OM), in order to improve their fertility, and better exploit the agricultural potential of this residue.

2. Materials and Methods

2.1. Source of olive mill pomace

In this study, we focused on an olive mill pomace (OMP) that has been collected from 3-phase cold-pressed process olive oil mill located at Baghaï, Khenchela Algeria. The olive mill pomace samples were collected in November 2020 and kept immediately until used at 4C°.

2.2. Sample of Soil

The soil used in this study was derived from a natural grove at (0 - 40 cm) depth that has been located at Khenchela (Algeria) (35◦ 29’ 41’’ N, 6◦ 55’ 27’’ E). The soil sample was oven-dried at 105 C° overnight, prior to use in the experiment, it was mixed and sieved through a 2 mm mesh to remove gravel, roots, and stones.

2.3. Experimental design

Experimental were carried out using a microcosm. Microcosms were plastic containers of 1 l with drain the Soil was divided into microcosms at a rate of 1000 g each. Olive mill pomace was added to the soil at a rate of R1: (50% w:w) and at a rate R2: (100% w:w) corresponding to the dose allowed by law in several Mediterranean countries 50–80 tons/ha/years. Furthermore, untreated soil was the control (C). All the experiment was carried out with three replicates for each one under laboratory condition.

2.3.1. pH, EC and, OM analysis

pH and Electrical Conductivity (EC) of olive mill pomace they were estimated according to the international method of 1/5 using a pH-meter and conductivity meter [8]. Organic matter was determined by calcining the sample for 1 h at 850°C in a muffle furnace [9].In the aqueous extract, pH and EC of the soil were determined using the ratios 2:5 (w/v) for pH and 1:5 (w/v) for EC by using a multiparameter [10], soil organic matter have been evaluated according to Sierra et al. (2007) [11].

2.4. Statistical analysis

The data obtained correspond to 3 repetitions were treated statistically analyzed by one-way ANOVA using (XLSTAT 2014.5.03) software.

3. Results and Discussions

3.1. Analyses of olive mill pomace

The analyses of olive mill pomace are mostly influenced by the methods used in the olive oil extraction process as well as other agronomic parameters. The compositions of olive mill pomace are reported in Table 1.

Table 1. Characteristics of olive mill pomace. Results are reported as mean ± SD of 3 different measurements.

Parameter	Value
pH	4.53 ± 0.06
Electrical conductivity (EC) mS cm^{-1}	12.08 ± 0.26
Organic matter (OM) %	84 ± 2.00

3.2. Analysis of soil after the amendment by the olive mill pomace

The one-way analysis of variance Table 2 showed that there was a very highly significant difference between all the treatments for the soil parameter pH, EC, and, OM with ($p<0.001$) for all parameters measured.

Table 2. The values of one-way ANOVA of the effect of olive mill pomace on soil analysis.

Source	DF	pH	EC	OM
Treatment	2	1,70200***	1,362000***	176,7000***
Error	24	0,01611	0,001367	0,006111

***: highly significant at 5% *: significant ns: not significant

3.2.1. Soil pH

According to the results obtained and summarized in Figure 1, the control had an alkaline pH (7.3 ± 0.52). While, the application of olive mill pomace caused a significant decrease in soil pH (5.40 ± 0.29), depending on the olive mill pomace rate were added to the soil (R2:100%), whereas the (R1:50%) doses were present a slight decrease in soil pH (6.62 ± 0.09) compared to the control. This decrease is mainly due to the acidity of the olive mill pomace used which is characterized by an acidic pH (4.53 ± 0.06); this acidic pH was due to the presence of organic acids (phenolic acids, fatty acids [12, 13]. Our results are confirmed by Aranda et al. (2015) [6] found that the soil becomes more acidic after application of olive mill by-products and only slightly modifies the soil pH due to the buffering capacity of the soil itself.

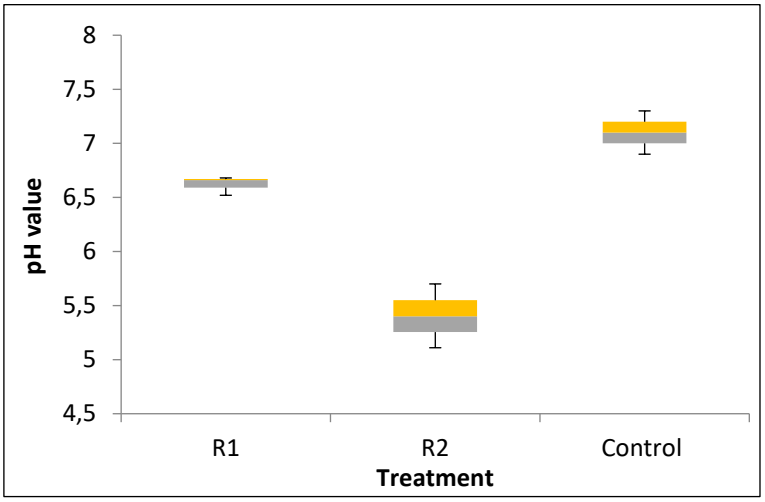

Figure. 1. Boxplots of soil pH indicating significant treatment effects found by analysis of variance (ANOVA).

3.2.2. Soil Electrical Conductivity (EC)

According to the results obtained and presented showed in Figure 2; our soil has an electrical conductivity of (0.47 ± 0.02 mS cm^{-1}) so it is classified as non-saline, this value reflects the mineral content present in this soil [7]. After the application of the olive mill pomace, a significant increase in the soil electrical conductivity was observed with the percentage of olive mill pomace add to the soil compared to the untreated control soil with (0.71 ± 0.05 mS cm^{-1}) for the R1 (50% w/w) classified as slightly salty, to (1.50 ± 0.3 mS cm^{-1}) for the R2 (100% w/w) which rendered the soil salty. This increase is related to the high concentration of salts present in olive mill pomace and was an indicator of the degree of mineralization of olive pomace [14].

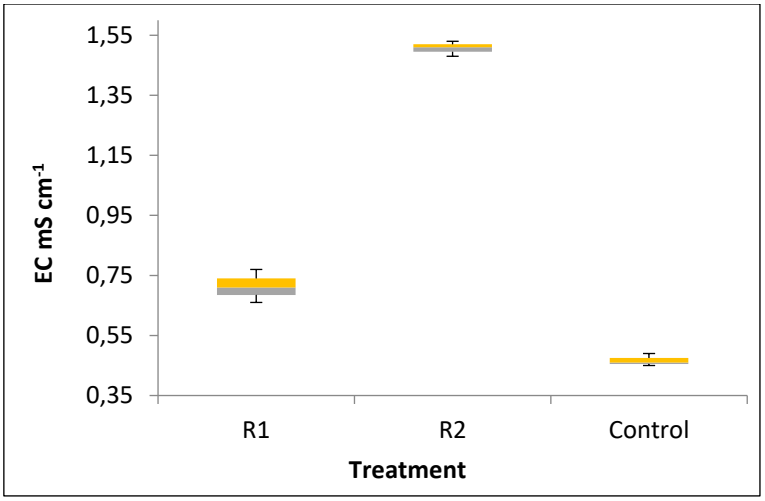

Figure 2. Boxplots of soil EC indicating significant treatment effects found by analysis of variance (ANOVA).

3.2.3. Soil organic matter (OM)

The analysis of variance Table 2 and Figure 3 was showed that the difference between the soil treatments with olive mill pomace was a highly significant ($p<0.001$) effect on the soil organic matter (OM) content. Furthermore, the results obtained showed also that the averages of OM increased in the soil compared to the control untreated soil (2.75 ± 0.09), and ranged from (3.22 ± 0.07 8.12 ± 0.09) with R1 and R2 respectively.

The increase in the soil OM as a function of the olive mill pomace rates applied was related to the richness of the olive mill pomace in organic matter (84 ± 2.00) [15]. The high organic matter in the soil improves soil water retention and increases total soil stability, rendering soils less sensitive to erosion [1]. Our results are in agreement with Aranda et al. (2015) [16] found that the soil organic matter was improved by the amendment with olive mill pomace.

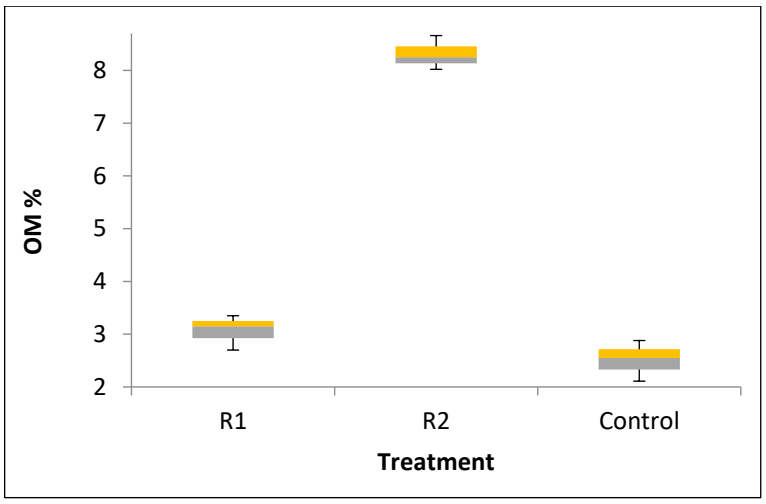

Figure 3. Boxplots of soil OM indicating significant treatment effects found by analysis of variance (ANOVA).

4. Conclusion

In this study, the amendment of soil by the olive-mill pomace at two different doses was effective in improving the soil organic matter. Moreover, the application of olive mill pomace causes an increase significantly in the acidification of the soils according to the doses used, also the treatment with olive mill pomace significantly increased the electrical conductivity and salinity of the soil compared to the control, this increase is proportional with the high salt content present in olive mill pomace. Further, the addition of olive mill pomace to the soil can constitute a significant and very important organic amendment. As a result, we can consider the olive mill pomace as a source of soil organic matter, also we recommend a pretreatment of the olive mill pomace to reduce their acidic pH and salt content prior to use as a soil amendment.

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