沙漠研究 **19**-1, 327- 330 (2009)
Journal of Arid Land Studies

"Desert Technology IX "
Refereed Paper

Olive mill waste water valorisation in agriculture
-Effects on the soil proprieties and barley yield-

Raja DAKHLI[1], Houcine TAAMALLAH[1], Kamel NAGAZ[1], Ridha LAMOURI[1]

Abstract: The spreading of olive mill waste water (OMWW) on sandy soil in Southern Tunisia represents an interesting alternative and new method for the treatment and the valorisation of this effluent. The main aim of this study was to investigate the use of OMWW as a fertilizer for Barley cultivation. In fact, the application of 50 (T1), 100 (T2) and 200 (T3) m^3/ha of this wastewater resulted in a significant improvement of the soil fertility. Indeed, the ratio carbon/nitrogen increased from 9 for the control to more than 22 for the T3 treatment. The potassium content showed also a considerable improvement (From 300 mg/kg for the control to more than 1988 mg/kg for the treatment T3). Because of its binding and hydrophobic effects, the application of OMWW resulted in a more stable soil and created mulch reducing the losses of water evaporation.

Regarding the production, compared to the control and after the spreading operation, a decreased seed yield has been recorded. In fact, compared to the control (1262.2 kg/ha), the seed yield recorded a clear decrease for the treatment 100 m^3/ha (762.9 kg/ha) and 200 m^3/ha 362.2 kg/ha). However, treatments of 50 m^3/ha recorded a light increase (1362.2 kg/ha). It was concluded that the OMWW applied with high doses (100 and 200 m^3/ha) reduce the production whereas the low doses (under 50 m^3/ha) improve the soil characteristics. Then, it is recommended that the OMWW can be applied with amounts less than 50 m^3/ha for Barley cultivation.

Key words: Barley, Olive mill wastewater, Seed yield, Soil, Valorization.

1. Introduction

Olive oil extraction produces large amounts of waste water, known as olive mill waste water (OMWW). This effluent has a high chemical oxygen demand, contains high level of phenolic compounds, and is therefore a cause of environmental pollution. In fact, the olive oil waste water (OMWW) constitutes serious environmental problems in Tunisia and in the world because of their high concentrations of polyphenols and other pollutants. The exploitation of this waste without preliminary treatment is very limited considering its toxicity for soils and plants. In Tunisia, 700,000 tons of OMWW, produced annually, are generating many types of pollution. They are dried in special basins and then put in heap to be used as compost while an important fraction of the product is poured directly in the natural channel beds (*wadi*). However, the richness of that sludge in mineral and organic compound raised to investigate other techniques to valorise this residue in agronomy. This work fits into this context and aims to study the impact of the spreading of OMWW on the physical and chemical soil properties and its effects on crop yields (Case of barley).

2. Materials and Methods

2.1. Experimental site

The experiments were conducted in the farmer located in the El FJE area (Medenine, Tunisia). The soil is characterised by a low organic matter and a sandy texture. It is also characterized by a high level of the electrical conductivity which increases with the depth. Indeed, this parameter increased from 5 dS/m in surface layer to more than 8 dS/m in depth (see **Table 1**). This salinity increase can be explained by an increase in the soil gypsum content since the bedrock is formed by the miopliocene clay and gypsum at the horizon 70-80 cm. OMWW was obtained from a local olive oil manufacture. Physical and chemical characteristics of the used effluent are presented in **Table 2**. The plant material is used with 2 barley varieties, *Hordeum vulgare Ardhaoui* and *Pakesteni* (Introduced variety).

[1] Institut des Régions Arides - 4119 El Fjè - Medenine - Tunisia

Table 1. The main physical and chemical characteristics of soil.

Depth (cm)	Clay (%)	Silt (%)	Sand (%)			Initial EC(ds/m)	CaCO3 Total (%)	Gypsum (%)	Organic matter (%).	pH
0-25	3.57	5.20	69.43	17.77	6.65	5.67	5.55	0.37	0.92	7.11
25-50	3.77	6.20	63.78	5.13	5.43	7.99	8.33	1.5	0.88	7.23
50-75	4.88	7.25	53.45	29.54	6.79	8.79	8.33	3.45	0.54	7.15

Table2: Principal physical and chemical properties of OMWW

pH	DR (%)	OM (%)	MM (%)	EC (ms/cm)
4,77	30	83	17	16.61

DR=dry matter; MM=Mineral Matter; OM=Organic Matter; EC=Electrical Conductivity.

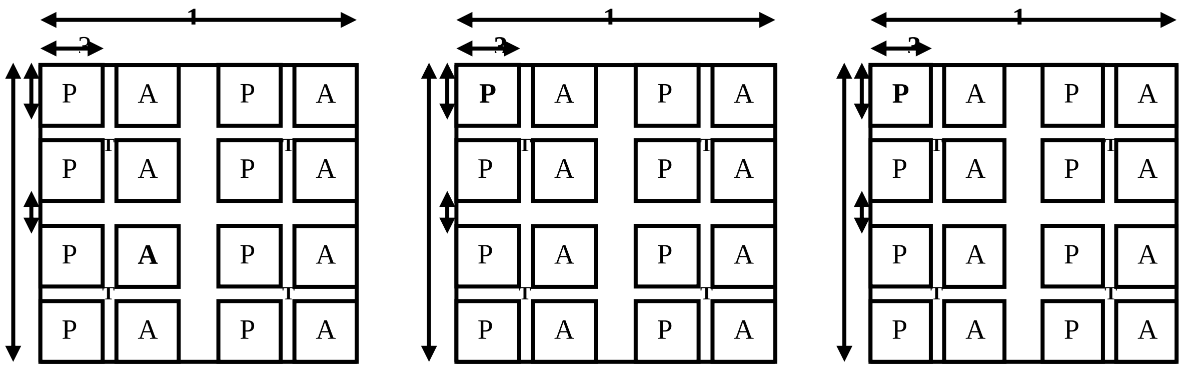

Fig. 1. Experimental design.

2.2. Experimental design

The adopted experimental design is the randomized block with 4 treatments of OMWW (Control treatment: T0=0 m^3/ha; T1=50 m^3/ha; T2=100 m^3/ha; T3=200 m^3/ha), 2 varieties of barley: *Ardhaoui (A)* and *Pakesteni (P)* in 3 repetitions

2.3. Studied parameters

Effect of OMWW on chemical and physical soil properties (organic matter, K exchangeable electrical conductivity, pH and soil content in Sodium, Chloride and Sulfate). Evaluation of Barley yield.

2.4. Statistical analysis

All statistical analysis was conducted using the SAS System for Windows version 9.00.

3. Results and discussion

3.1. Effect of OMWW on chemical and physical soil properties

OMWW application does not affect the soil pH because of the high concentration in limestone making a power buffer for the incorporated acidic products in the soil (Ros de Ursinos F 1996). The application of OMWW on alkaline and limestone soils, frequent in the Mediterranean areas, do not affect the soil pH (Levi-Minzi *et al.*, 1992). Spreading OMWW leads to a significant increase in soil salinity. Indeed, from an electrical conductivity less than 5 dS/m (The Control), the soil salinity increases to more than 7 dS/m for the plot that received the highest dose (T3: 200 m^3/ha). The difference is statistically significant especially for higher doses (T2 = 100 m^3/ha and T3 = 200 m3/ha). Sodium increases with the administrated OMWW doses. Compared to the control (5662 mg/Kg), the Sodium content showed a considerable improvement for the treatment T2: 200 m^3/ha (7837.83 mg/Kg) and T3: 200 m^3/ha (10640.8

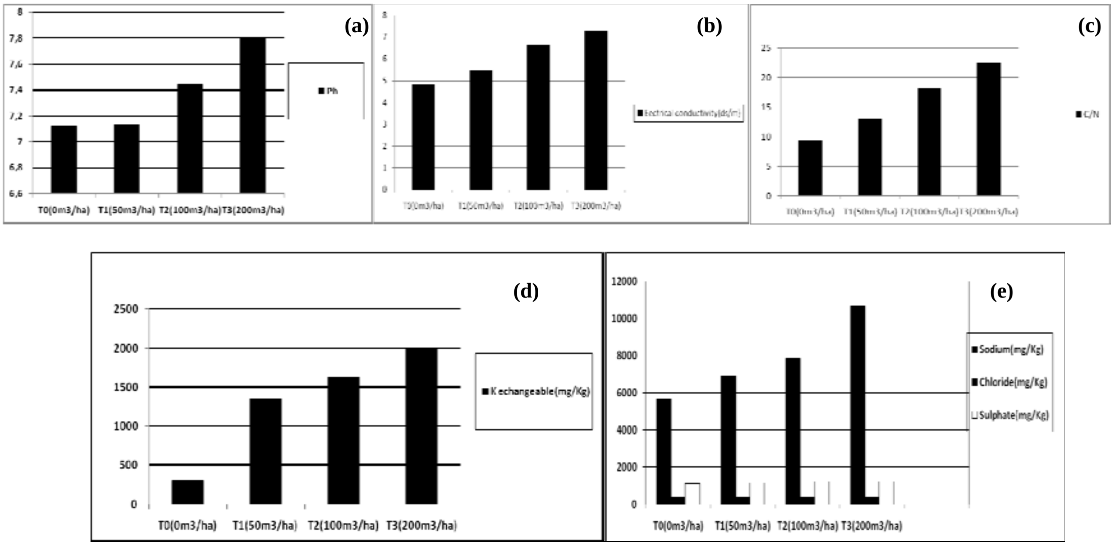

Fig. 2. Effect of OMWW on soil pH (a), on soil electrical conductivity (b), on soil ratio Carbon/Nitrogen (c), on soil K exchangeable concentration (d) and on soil Content in Sodium, Chloride.and Sulphate (e).

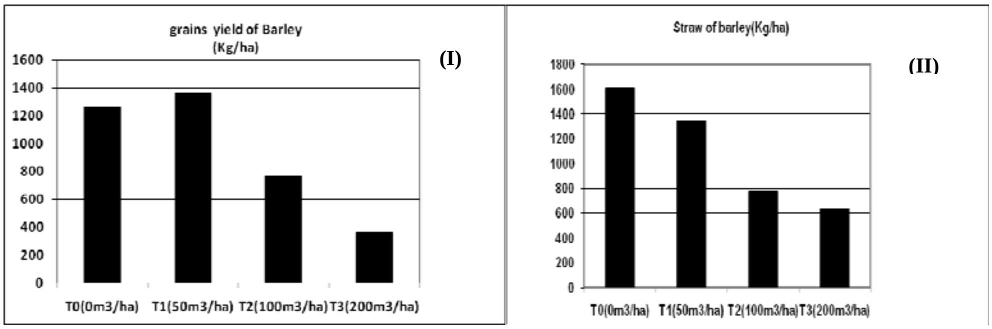

Fig. 3. Effect of spreading OMWW on Barley dry matter (I) and seed yield (II).

mg/Kg). However, Chloride and Sulphate recorded an increase in soil without being statistically different for the control. The rate of organic matter increases with the doses administrated. Indeed, the ratio carbon/nitrogen increases from 9 for the control to more than 22 for the T3 treatment. The potassium content showed also a considerable improvement (From 300 mg/kg for the control to more than 1988 mg/kg for the T3 treatment). Because of its binding and hydrophobic effects, the application of OMWW resulted in a more stable soil and created mulch reducing the losses of water evaporation. The application of 50 m^3/ha (T1), 100 m^3/ha (T2) and 200 m^3/ha (T3) m^3/ha of this wastewater resulted in a significant improvement of the soil fertility (Taamallah, 2007).

3.2. Effect of OMWW on Barley yield

The results showed that the yield of both grain and dry matter was affected by OMWW supplies. Regarding the production, compared to the control and after the spreading operation, a decreased grain yield has been recorded. In fact, compared to the control (1262.2 kg/ha), the seed yield recorded a clear decrease for the treatment 100 m^3/ha (762.9 kg/ha) and 200 m^3/ha 362.2 kg/ha). However, treatments of 50 m^3/ha recorded a light increase (1362.2 kg/ha) without being statistically different from the control. The application of OMWW has affected also Barley dry matter yield for treatments 100 m^3/ha (T2) and 200 m^3/ha (T3). OMWW cause a light decrease of dry matter production for respectively 100 m^3/ha and 200 m^3/ha treatment (768.3 kg/ha and 637 kg/ha) compared to the control (1600 kg/ha).

4. Conclusion

Containing many nutritive elements leading to an improvement of agricultural production, OMWW can be considered as a fertilizer for Barley cultivation. Indeed, used with amounts less than 50 m^3/ha, OMWW do not present any risks for the soil salinity, the phenolic substances concentration, the potassium content and acidity. In addition, they generate an improvement of some physical and chemical soil properties and an increase in the barley yields whereas a spreading with strong amounts of the OMWW causes an ionic imbalance and an increase in the soil salinity. It was concluded that the OMWW applied with high doses (100 and 200 m^3/ha) reduce the production whereas the low doses (less than 50 m^3/ha) improve the soil characteristics. It provides an economically acceptable production alternative for Barley cultivation and can reduce the problems caused by this effluent.

References

Levi Minzi R., Saviozzi A., Riffaldi R., Falzo L. (1992): L'épandage au champ des eaux de végétation, effets sur les propriétés des sols. *Olivae*, **40**: 20-25.

Ros de Ursinos F., Berndt L., Geissen K., Kachouri M., Klimm E. (1996): *Les expériences méditerranéennes dans le traitement et l'élimination des eaux résiduaires des huileries d'olives*. Coopération Tunisie-Allemagne. 380 p.

Taamallah H. (2007): *L'épandage des Margines au niveau des champs d'oliviers : une alternative pour la valorisation de cet effluent des huileries d'olives*. Thèse de doctorat (Ph.D), facult de sciences en bio ingéniérie, université de Gent, p180.