VEGETATION WATER USED AS A FERTILIZER ON YOUNG OLIVE PLANTS

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Abstract

The effect of irrigation with five doses of raw olive mill waste water (0, 2, 4, 6 and 8 liters / pot) on the growth of young olive trees (cv. Chemlali) grown in pots containing 16 kg of sandy soil has been studied. Preliminary results over a period of two years showed that, in consideration of its enriching effect on organic matter, nitrogen, exchangeable K and P, the possibility to use olive mill waste water to improve the soil fertility was an interesting process. A few days after irrigation with vegetation water, the soil showed an intense microbial activity and microbiological analysis showed a relative abundance of nitrogen fixers. Regarding the influence of the treatments on tree growth, waste water given to growing trees, in high doses (6 and 8 liters / pot) was phytotoxic and plants died. However, when the waste water was applied before planting, 100 % of the trees survived.

1. Introduction

In Tunisia, the olive oil extraction process generates more than 500.000 t/year of olive mill waste water (OMW). This effluent is kept in evaporation ponds near to the great urban centers and produce pollution by strong smell and other nuisances. Furthermore, in high yield years pond capacities become insufficient.

In consideration of its elevated load of organic substances (biological oxygen demand: BOD_5 up to 90 g/l, Chemical oxygen demand: COD up to 200 g/l) and in particular phenolics and fatty acids, which place it among the effluents highly harmful to the environment, more investigations were carried out to insure OMW elimination and valorization.

In experiments were done using OMW for irrigating olive plants (Bricoli and Lombardi, 1990) and a positive effect of the lower doses on plant growth was stored. A lethal rate with 800 cc/plant was noticed. In olive tree grovelands, OMW was used to improve the soil fertility (Ben Rouina, 1994) and no phytotoxic effect was signaled with a rate of 20 l/m^2.

Garcia-Ortiz *et al.* (1995) noticed a high yield in maize when OMW was used as a fertilizer. Maize where raw OMW was spread at 200 or 300 l/m^2 showed an average crop of 12.000 kg/ha, while without OMW, the crop was 2.000 kg/ha only. Ammar *et al.* (1997) noticed the decline of 80 % in the growth of tomato plants when OMW doses exceeded 2 liters/pot.

On the basis of these results it was thought that the OMW could be tested as a fertilizer to evaluate its influence on the growth of young olive plants and eventually to determine the lethal doses and the effect of flooding phases.

2. Material and methods

Experiments were carried out in 1996 and 1997 at Institut de l'Olivier de Tunisie with the cv. Chemlali. Olive plants of 12 months old raised from herbaceous cuttings were planted in vases of 12 liters capacity filled with 16 kg of agricultural soil from the Châal area.

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The olive waste water originates from a traditional process and containes 12 % of dry matter. The doses were 0 liter (control, untreated plants), 2, 4, 6 and 8 liters/plant. Each dose was divided in 4 applications over 15 intervals.

In the first year (1996), trees were planted in November 1995 and OMW was applied between January and February 1996. In the second year, the OMW was applied two months before planting in January 1997 (10 plants / treatment). Growth was evaluated monthly by measuring the length of the principal stem, growth of all shoots produced, and eventually determining plant viability. Soil analysis was made before the application of OMW and after the entire dose was furnished. Soil microbiological analysis were made and the total number of fungi and bacterial flora was determined (Ammar *et al.*, 1997).

3. Results and discussions

Table 1 shows the physico-chemical characteristics of the OMW that was used. It should be pointed out that the effluent had a high capacity to improve the land fertility. The high content of dry matter (107 g/l) was constituted by organic matter (91g/l) and minerals (22 g/l).

Agricultural soil had the following composition, clay: 6 %, silt: 3 % and sand: 91 %. When raw OMW was sprayed, soil fertility was evaluated and their organic and mineral contents were presented in table 2. Results pointed out an increase of EC which evolved from 2.18 ms/cm up to 9.75 ms/cm and a pH decrease from 8.2 down to 7. OMW rates were between 0.86% for untreated soil and 2.78% with 8 liters of OMW/pot. A similar trend was unregistered with K_2O, P_2O_5 and N which increased significantly (up to 400 % for K_2O and 380 % for P_2O_5) when OMW doses exceed 4 liters/pot.

When the OMW was applied after planting (in the first year) the majority of plants died if doses exceded 4 liters/pot. Soon after the treatment the leaves faded and fell and the plants died after 30-50 days. With 6 and 8 liters, death rates were respectively 50 and 90%. However, in the second year when OMW irrigation was stopped two months before planting, the mortality rate was nil even with doses up to 6 or 8 liters/pot. (table 3)

Considering the plant growth, we can see that the total shoot elongation was significantly dependent of the OMW dose. Six months after planting, the elongation rate of the control plants expressed by the total length of the shoots was 165 cm/ plant. In the same term it ranged between 226 and 300 cm/plant when OMW was applied. Differences were highly significant at 1% level (ANOVA test).

Table 4 shows a positive impact of OMW spray on microbial flora. When OMW doses were increased to 6 liters/pot, the total number of microflora also increased (from $2.3x10^3$ for untreated soil to 1.3 10^7 with 6 liters treatment). In the meantime with an 8 liters dose the total number of microflora had decreased ($3.8x10^4$ ucf/g of soil). Similar results were observed for mesophile and thermophile bacteria. In addition, we noticed a relative abundance of nitrogen fixers and we identified two strains of them (Azotobacter and Azomonas).

References

Ammar, E., Kallel, M. and Ben Rouina, B. 1997. Potential horticultural utilization of olive oil processing waste water. 3th International Symposium Olive Growing. Chania, Greece, 1997.

Ben Rouina, B. 1994. Repercussions agronomiques de l'épandage des margines comme fertilisant. International Conference on Land and Water Ressources Management in the Mediterranean Region, Vol.II 583-594;

Bricolli-Bati, C. and Lombardo, N. 1990. Effects of olive oil waste water irrigation on young olive plants. Acta Horticulturae Vol.286, 489-491.

Garcia-Ortiz, R., Giraldez, J. and Fernandez, P.R. 1995. El riego con Alpechin. Una alternativa al lagunaje. Eds Junta de Andalucia, p13.

Table 1. Physico chemical characteristics of OMW used (mean of 2 years).

pH	CE ms/cm	COD g/l	BOD_5 g/l	Dry M. g/l	Polyph g/l	R. Sug. g/l	Gluc. g/l	Suspend. solid g/l
5.5	18.6	106	17.5	107	5.8	11.4	3.9	43
Fatty g/l	V. M g/l	N g/l	P g/l	K g/l	Mg g/l	Na g/l	Ca g/l	Cl g/l
7	35	0.74	0.4	7.5	0.65	1.31	0.71	0.56

Table 2. Evolution of soil physico chemical characters few days after OMW spray.

OMW doses	pH	EC ms/cm	K_2O ppm	P_2O_5 ppm	N ‰	Na ‰	Ca ‰	Mg ‰	MO %	C %
Control	8.2	2.18	165	170	.56	.05	4.1	0.14	0.86	0.5
2 liters	8.2	6.15	640	408	.65	.08	4.9	0.17	2.58	1.5
4 liters	7.2	8.35	716	520	.78	.10	4.7	0.13	2.29	1.3
6 liters	7.0	8.33	700	613	.84	.12	4.4	0.14	2.58	1.5
8 liters	7.0	9.75	735	620	.81	.09	4.9	0.15	2.78	1.6

Table 3. Total shoots length and rates of plants death according to different OMW doses.

OMW doses	at planting	after 3 months	after 6 months	after 9 months	after 12 months	rate of plant death (%)
			1996			
Control	37.9	42.3	153.0	183.5	215.0	0
2 liters	34.1	50.0	287.5	327.5	343.5	0
4 liters	42.5	57.9	301.0	343.0	350.2	20
6 liters	36.6	52.8	271.9	293.6	298.1	50
8 liters	44.1	-*	-*	-*	-*	90
			1997			
Control	31.5	59.3	165.0	-	-	0
2 liters	35.2	61.1	226.3	-	-	10
4 liters	29.6	56.8	208.5	-	-	0
6 liters	30.9	60.2	241.2	-	-	0
8 liters	27.7	53.5	296.7	-	-	0

* Only one plant survived.

Table 4. Microflora present in the soil 3 months after been treated with different doses of raw OMW (ucf/g of soil)

OMW doses Liters / pot	Mesophile bacteria	Thermophile bacteria	Azotobacter and Azomonas	yeat and mould
0	1.5×10^4	2.2×10^3	2.3×10^3	4.4×10^3
2	1.9×10^6	2.9×10^4	1.2×10^5	3.1×10^3
4	2.1×10^6	3.3×10^4	1.5×10^7	3.1×10^3
6	1.4×10^5	2.7×10^5	1.7×10^7	2.5×10^3
8	ND	1.8×10^4	2.6×10^4	3.6×10^3