ECONOMIC BENEFIT OF USING TREATED WASTEWATER FOR IRRIGATION IN THE BEKAA REGION, LEBANON

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ABSTRACT

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In this study, effect of using treated wastewater secondary effluent on the growth and yield of grapes was evaluated. The wastewater quality assessment indicated that some parameters did not comply with Lebanese standards for crop irrigation. Further studies should be conducted on the quality of crops irrigated using treated and raw wastewater to assess the risks on human health, soil and groundwater. Results showed that the overall biomass increased in plants irrigated with wastewater and grape production per plant increased by 40%.

Keywords: treated wastewater, crops, water conservation.

INTRODUCTION

Scarcity of fresh water in the Bekaa region has increased during the past decades, thus using treated wastewater from the newly established wastewater treatment plants was welcomed by farmers and local authorities, mostly due to the wide range of benefits such as conservation of fresh water, reducing the production cost, high level of organic substances that accompany it. An earlier study by Al-Abdoulqader and Al-Jaloud (2003) indicated that the use of recycled sewage water in irrigation of field crops saved up to 45% in fertilizers cost for wheat crop and 94% for alfalfa crop compared to irrigation with well water. They also stated that the usage of sewage water in irrigation of wheat and alfafa crop increased their yield by 11 and 23%, respectively, and consequently increased the profit by 14 and 28%, respectively, as compare to irrigation with well water.

Karaa et al. (2005) reported in a previous study that in Lebanon, like in other Mediterranean countries, the use of wastewater is becoming practical in agriculture, but without awareness from users about their side effects on human health and crop production. This source of pollution constitutes a direct threat to the vulnerable underground water. Accordingly, corrective attempts such as integrated water resource management and reuse strategy of treated wastewater are being considered.

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Using untreated wastewater in crop production could lead to heavy metals and microbiological contamination of soil and crops, thus posing serious threats to human health and ground water resources. This study aimed to evaluate the effect of using treated wastewater on the growth and yield of grapes, and assess the quality of wastewater for irrigation in the Bekaa region of Lebanon.

MATERIALS AND METHODS

Experimental design

Grape cultivation experiments were conducted at the Lebanese Agriculture Research Institute (LARI) in Tell Amara, Bekaa region. The soil at the experimental site is classified as alluvial clay.

Four grape growers in Ablah village were selected for the experiment. Land size and willingness of farmers to participate in this study were the main criteria for selection. Experimental plots had a size varying between 0.5 ha and 3.5 ha. Irrigation systems varied from drip irrigation to sprinklers.

Irrigation water sources

Experimental plots were irrigated during 2014 and 2015 seasons with fresh well water and treated wastewater from Ablah Wastewater Treatment Plant (AWTP), respectively. Each grape grower has his own private well. AWTP was the main source of irrigation during the second season (2015), and water was transported to the fields via wastewater supply networks directly from the plant.

Irrigation systems

Ablah wastewater treatment plant was built by USAID funded initiative in 2012. The initial design of the plant was made to serve about 9480 people in Ablah, Nabi Ayla and Niha villages, but the networks from Nabi Ayla and Niha were damaged by farmers in order to use the row waste water before reaching the treatment plant. The plant was designed in a way to reduce contamination of the Litany River. 1330 houses are connected to the plant, with secondary treatment of 2000 m3 per day. The major part of the treated wastewater flows to the Litani River.

In recent years a large number of Lebanese growers have moved from gravitational flow furrow system to sophisticated drip and micro-jet irrigation systems, allowing for more economic use of water resources. The study showed that the using the new technique such as the drip irrigation increased the yield by 30%-40%.

Data collection and statistical analyses

Information related to crop yield, fertilizer's cost and net income for each grape grower were collected from farmers. The collected data from each grower in each experimental field was statistically analyzed using the analysis of variance procedures and mean separation under the criteria of least significant difference (LSD) test. The analysis was carried out based

on the experimental design used, and after applying the assumptions of the statistical analysis according to El-Nakhlawy (2010).

RESULTS AND DISCUSSION

Results in Table 1 indicated that all assessed parameters were above the FAO acceptable limits. This fact requires serious attention and calls to identify the causes for the low quality of effluent water and adopt solutions to encourage growers to use such water for irrigation purposes. This is equally important to consumers of agricultural production.

TABLE 1

Laboratory Results of Influent and Effluent Water at the Ablah Wastewater Treatment Plant

Parameters	Influent to Ablah Station	Effluents from Ablah station	Acceptable limits (FAO)
BOD5[i] (mg/l)	708	200	25
COD [1](mg/l)	1700	142	125
Total Suspended Solid Waste (mg/l)	6780	110	<60
Total Nitrogen (mg/l)	99	45	5-30
Total Phosphorus (mg/l)	1.93	1.67	10
Total Potassium (mg/l)	35	40	
pH	8.4	8.4	6-9

[1]Biochemical oxygen demand is a measure of effluent strength in terms of the amount of dissolved oxygen utilized by microorganisms during the oxidation of organic components in the effluent.
[2]Chemical oxygen demand. The standard method for indirect measurement of the amount of pollution (that cannot be oxidized biologically) in a sample of water.

Mean yield of grape crops obtained are presented in Table 2. The effect of wastewater quality application on yield/ha and weight /plant, biomass and grape production per plant was increased from 14.3 to 40%, compared with traditional methods of using fresh well water for irrigation.

Table 3 shows decrease in pumping cost which varied from 28 to 82 %, due to the high cost of fuel and pumps, and maintenance of the overall pumping system. The positive response of using wastewater in irrigation of grape crop may be due to the increase in the

absorption of macro and micro elements present in the wastewater, and was reflected in the increase of overall biomass and grape yield/ha.

TABLE 2

Effect of the Use of Treated Wastewater on Grape Yield in Central Bekaa, Lebanon

Farmers	Yield (T/ha) Fresh well water, 2014	Yield (T/ha) Treated wastewater, 2015	Percentage of yield increase
Grower 1	7.17	10	40.00%
Grower 2	20	26	30.00%
Grower 3	5.6	6.4	14.29%
Grower 4	6	7	16.67%

TABLE 3

Decrease in Pumping Cost Resulted from using Treated Wastewater by the Four Growers Involved in the Study

Farmers	Crop Type	Type of Irrigation used	Pumping cost without using wastewater	Pumping Cost when wastewater was used	Cost reduction (%)
Grower 1	Grape	Sprinkler	6,300,000.00 L.L	4,500,000.00 L.L	-28.57%
Grower 2	Grape	Drip	9,000,000.00 L.L	1,575.000.00 L.L	-82.50%
Grower 3	Grape	Sprinkler	1,800,000.00 L.L	1,000,000.00 L.L	-44.44%
Grower 4	Grape	Sprinkler	1,800,000.00 L.L	1,000,000.00 L.L	-44.44%

In general, the results obtained illustrated the significant interaction between cost of crop production and water quality. The positive effect of irrigation with treated wastewater on yield might be due to the increase of nutrients in the soil under wastewater irrigation. This justification is supported by previous independent studies (Singh and Agrawal, 2009; Khan et al., 2011 and Thapliyal et al., 2011). Moreover, Zavadil (2009) reported that primary treated wastewater increased crops yield.

The users of polluted water may therefore face multiple problems since the use of untreated waste water for irrigation can cause many problems; such as soil degradation and contamination of groundwater. The biological and chemical contamination which can affect crop production positively, can have negative effect on human and animal health. A detailed

knowledge of these problems is a pre-requisite for any step to move forward in using contaminated water for irrigation.

Grape growers have realized the importance of waste water to fertilize their crops, in addition to its availability all year round at low or no cost, hence they did not hesitate to use it to irrigate field crops. Some farmers in the same area use raw waste water only because they don't have access to fresh water or treated wastewater. It is noted that while some farmers faced water shortage due to lack of access to fresh water sources because of distance, some faced water shortage due to their inability to pay for it.

The practice of using treated wastewater for irrigation in Bekaa area, might in the long term, be an important incentive towards improved treatment. Achieving good hygienic conditions with low or no suspended solids while preserving the nutrients in the wastewater should be a major objective towards economizing water use for irrigation.

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