

DISINFECTION OF TREATED WASTEWATER AND THEIR REUSE FOR IRRIGATION OF GOLF GRASS: CASE OF THE M'ZAR PLANT OF AGADIR-MOROCCO

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Abstract

Despite the bacterial load of treated wastewater (TWW) of the plant M'zar of Agadir, their high content in nutrients (NPK) promotes their reuse, after disinfection, in irrigation of golf grass. This study reports the results of disinfection of TWW of the M'zar plant using sodium hypochlorite and reuse of disinfected waters for irrigation purpose of three varieties of grass (pencross, english ray grass, mixture of english ray grass and red fescue). The results obtained when the grass is irrigated by the disinfected TWW are compared to those obtained when the aquifer waters (AW) are used. The grass irrigated by the disinfected TWW has a lack of pathogenic germs, but its % of germination; number of tillers and leaf length are influenced by water salinity.

Keywords: treated wastewater, disinfection, aquifer waters, irrigation, golf grass.

Introduction

The region of Agadir is an agricultural region characterized by an arid climate, limited water resources and nutrient poor soils. The present potential of the wastewaters treated by the plant M'zar of Agadir, likely to be used without any restriction for irrigation purpose (category A WHO norms), is of 10 000 m³/day and will reach 50 000 m³/day by the horizon of 2011. Gulfs are water consuming and occupy 30.5% of the total area of green spaces in Agadir. Former studies conducted on the reuse of TWW of the plant M'zar for golf irrigation purpose showed positive impact of these waters owing to their high content in nutrients (NPK). Nevertheless these waters still need to be disinfected to avoid exposure of golf players to health risks associated the reuse of TWW and enhance acceptance of this practice.

This study focuses on disinfecting the TWW using sodium hypochlorite. It presents the results of the tests conducted in order to assess the influence of the reuse of disinfected TWW, for irrigation of golf grass, on parameters such as germination and growth of grass in comparison of use of aquifer water for irrigation.

Methods

After determining the chlorine demand of TWW, disinfection is carried out using 80 mg / l of bleach (Break point). A follow-up of 41 days was conducted to study the feasibility of reusing the disinfected TWW for golf irrigation. Three varieties of grass (pencross (V1), english ray grass (V2), mixture of english ray grass and red fescue (V3)) are used on 3 parcels of land (P1, P2, P3). For comparison purpose, the same tests are reproduced in the same conditions while using groundwater. Every parcel contains a layer of 20 cm of soil composed of 75% of the plant earth and 25% of sand. The impact of irrigation by the disinfected TWW is evaluated by conducting germination tests and conducting bacteriological analysis on samples of the aerial part of the three varieties of grass irrigated by disinfected and non disinfected waters.

Results and discussion

The evolution of the percentage of germination of varieties V1, V2 and V3 is favored by aquifer water until the 13th day. While, it is retarded by dissolved salts in the disinfected TWW during the same phase. After the thirteenth day, the germination percentage is stable and reaches its maximum. The salts carried by the TWW cause an increase in the osmotic pressure of soil solution which prevents the seeds imbibitions and leads subsequently to a poor port and a reduction in yield (Asalesny et al., 2007). Thus, irrigation with disinfected TWW has led to more than 50% of reduction in the maximum germination percentage for all varieties compared to irrigation with ground water (see Figure 1).

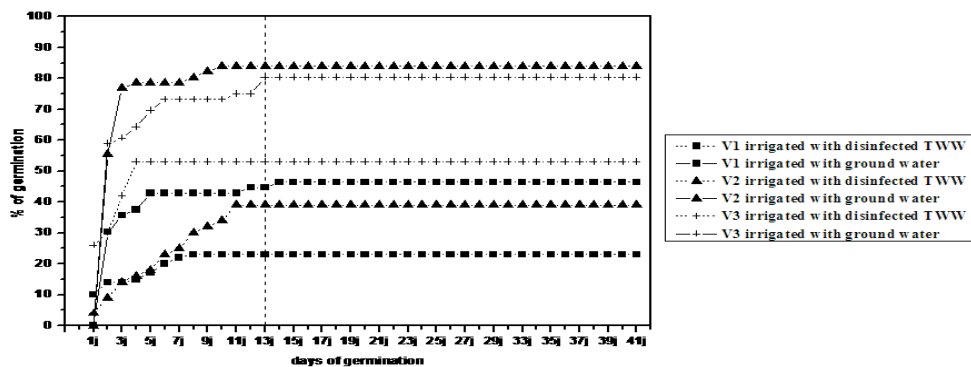


Figure 1. Evolution of the percentage of germination of the three varieties of seeds irrigated with AW and disinfected TWW.

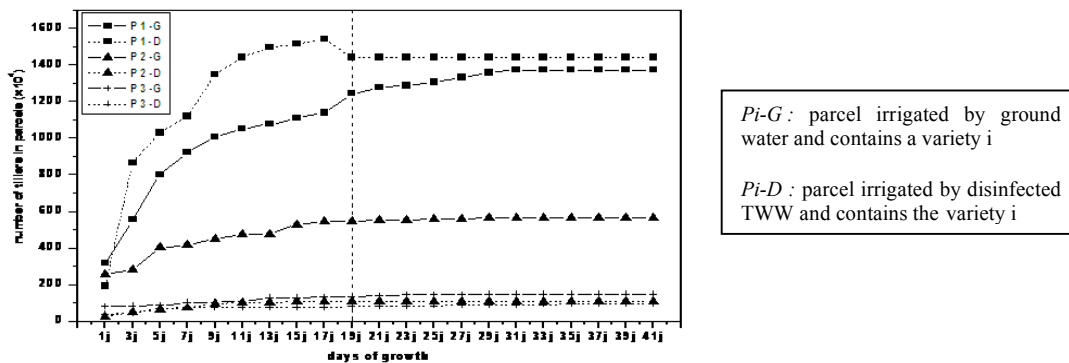


Figure 2 : Evolution of the number of tillers in parcels of land irrigated with the AW and the disinfected TWW.

Before the maximal germination rate was achieved, we can't estimate the effect of irrigation by disinfected TWW on the evolution of leaf length. However after the 19th day of growth, it can be seen that the irrigation by disinfected TWW, enhance the raise of leaf length compared to irrigation by the AW and this is true for all grass varieties. It affects more the germination percentage and the phenomenon of tillering than leaf length raise. This is due to the concentration of sodium and chloride ions that influence the grass plant growth depending on its resistance to salinity (see Figure 2).

At the end of the follow-up period (41 days), analysis on samples of the aerial part of the three varieties of grass, irrigated by disinfected and non disinfected waters, are performed. The bacteriological analysis of non disinfected TWW give $1,32 \cdot 10^4$; $7,06 \cdot 10^4$ and $4,29 \cdot 10^3$ CFU/100 ml as annual average respectively for Fecal Coliforms (FC), Total Coliforms (TC) and Fecal Streptococci (FS). The analysis of irrigated golf grass by these waters give results that vary between (190, 000 and 590 000 CFU / g); (160 and 510 CFU / g) respectively for CT and CF. For SF, the analysis give 100 and 500 CFU / g. Salmonella is absent for all varieties irrigated by TWW (Table 1). These values are close to that of grass irrigated with waters from the aquifer which shows no faecal contamination as CF, CT, FS and Salmonella were absent in a 25 grams sample. These results lead us to believe that the grass plant has had external contamination originating from environmental or accidental pollution.

To confirm this hypothesis, analysis of a grass sample, taken from a golf outside of the treatment plant where land tests are located, confirms the results obtained for grass irrigated by disinfected TWW which present a concentration of CT and aerobic microorganisms strongly linked to environmental pollution (Benyakhlef, 1998; Mimouni, 2004).

Table 1: Bacteriological analysis of grass irrigated by disinfected TWW at the end of 41 days follow-up.

Parameters	Grass irrigated by disinfected TWW		
	V1	V2	V3
Total coliformes (UFC/gr)	4,3E+05	8,2E +04	3,2E+05
Faecal coliformes UFC/gr	< 10	<10	<10
Fecal streptococci UFC/gr	< 100	<100	<100
Salmonelles UFC/25 gr	absence	absence	absence

Conclusions

The bacteriological analysis of the grass irrigated by TWW showed that concentrations of fecal and total coliforms and fecal streptococci are very high, while there is an absence of salmonella. Disinfection of treated wastewater by sodium hypochlorite was tested. The results are satisfactory and the treated water shows, after disinfection, an absence of fecal contamination. But the irrigation with TWW disinfected by using sodium hypochlorite was found to have negative effects due to the increase of salinity. It can be concluded that the TWW disinfected using sodium hypochlorite are not suitable for irrigation except if certain conditions exist : good soil leaching, salt-tolerant plants and highly permeable soils." in preparation"

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