

ORIGINAL SCIENTIFIC PAPER

Germination Of Grass Seeds with Recycling Waste Water

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Abstract

This study was designed to determine the effects of residual water irrigation on the rate and percentage of germination of grass seeds. Germination tests were carried out to compare the seeds irrigated with recycling waste water with seeds irrigated with distilled water. Test with *Festuca arundinacea* Sch. and *Agrostis tenuis* L. seeds was performed under laboratory conditions. Parameters used to evaluate germination were: number of germinated seeds (G_{max}), mean germination time (MGT), the time required for 1 to 75%, of the seeds to germinate (T_1 , T_{10} , T_{25} , T_{50} and T_{75}). The evaluated parameters for both seeds irrigated with recycled waste water were below the control seeds parameters. These reductions involve that germination rate was increased. Recycling waste water could be used for irrigation of grass seeds because produces a beneficial effect in germination rate and percentage.

Key words: recycling water, mean germination time, grass seeds, *Festuca arundinacea*, *Agrostis tenuis*

Introduction

The purpose of the present study was to evaluate the effect on the rate and percentage germination of grass seeds (*Festuca arundinacea* Sch. and *Agrostis tenuis*, L.) of residual water irrigation. Seeds were selected because mixtures of both seeds are very often used on grass courts. The use of regenerated and recycled water for irrigation of golf courses or other recreational areas is a common practice in developed countries. The recycling water from wastewater treatment plant after a primary or secondary treatment process could be used in sport yards, public garden and leisure or green areas. This application allows the economical resources generated by creation of green areas that do not require supplementary water supply.

Reuse, understood to be the use of water that has been used previously, has always been present in Spain (MIE, 2007). This fact can be understood if we consider the water systems of a large part of our territory. In this context, the reuse of water has always been seen as an alternative or complementary source of the hydraulic resource, and as such, historically, reused water has been used (Seoanez, 1999). A distinction can be made between the direct or planned reuse of water, when water is used for purposes such as agriculture, industry, recreational uses, etc. before it is discharged into the environment, and indirect or unplanned reuse, when water is collected after it has been treated. Tertiary treatment of the water is usually required for it to be reused. This is known as the regeneration process. Regenerated water, therefore, is water that has been submitted to a regeneration treatment and that is suitable for reuse (Junta de Extremadura, 1992, MAPA, 1994).

Soft water is a marvellous resource but is not inexhaustible. It represents no more than 0.01% of the water in the world and continuously circulates in the form of rain from evaporation or from the displacement of evaporation. Wastewater is integrated within this cycle through infiltration or runoff. World consumption of water is constantly increasing; quantities of water used vary according to countries and standards of living. The responsibility of developed countries in the preservation of resources is therefore essential, both in terms

of quantity and quality (Izembart and Le Boudec, 2003).

Mediterranean countries are characterized by a serious hydric disequilibrium between demanded water by the population and supplied water. This disequilibrium is due principally to the irregular precipitations, high temperature, the increasing irrigated areas and tourism impact. The Water Administration (Spanish environment institution depending on “Ministerio de Medio Ambiente” MIE) considers reused water to be an alternative source of this resource that is as valid as others for certain uses and therefore as an activity to promote and to incorporate into the integrated planning of the resource. The law Urban Waste Water Directive, 91/271, which deals with the treatment of urban waste water, has been implemented in Spain as from 1995. According to the EU directive and its Spanish version, all waste water must be collected and treated from January 1st, 2006.

Material and methods

The grass seeds used were *Festuca arundinacea* Sch. and *Agrostis tenuis*, L., which had high viability and homogeneity. Test was performed under laboratory conditions with natural light and the temperature average was $20 \pm 2^\circ\text{C}$. Germination tests were carried out using an experimental design with groups of 200 seeds located on specifically germination containers (50 seeds per container, then four replicates $n=4$ were obtained) as showed in picture 1. The experimental group (E) was irrigated with recycling waste water and control group (C) was irrigated with distilled water. The germination test was performed according to the guidelines issued by the International Seed Testing Association (ISTA Rules, 1999) but we have used germination containers instead the Petri dishes recommended by these rules.

Germination container



Picture 1.
Detail of containers especially designed to germination test. Seeds are placed in filter paper and water goes up by capillarity.

Parameters used to evaluate germination were: number of germinated seeds (G_{\max}), mean germination time (MGT), the time required for 1%, 10%, 25% etc. of the seeds to germinate (T_1 , T_{10} , T_{25} , T_{50} and T_{75}) provided by the Seed calculator software package (Jalink and van der Schoor, 2002). Germination curves have been plotted. Germination tests were realized for three months corresponding to the 2007 spring season.

Statistical analysis. Data of germination obtained in germination tests were compared by the t-student values and the p-values were calculated to test for significant differences between experimental and control groups using the Seed calculator software for seeds germination data analysis.

Results and discussion

Table 1 shows the percentage of germination (G_{max}) and the germination parameters (T_1 - T_{75} , MGT) calculated for *Festuca arundinacea*, Sch. and *Agrostis tenuis*, L. seeds. Results are expressed in days as mean and their standard error (SEM).

Table 1. Germination parameters for *Festuca arundinacea*, Sch. and *Agrostis tenuis*, L. seeds

Water	Gmax (%)	Time (day) $\bar{x} \pm SEM$					
		T ₁	T ₁₀	T ₂₅	T ₅₀	T ₇₅	MGT
<i>Festuca arundinacea</i> , Sch							
C	81.50	2.49	3.11	3.59	4.42	7.33	4.63
	± 2.50	± 0.20	± 0.08	± 0.01	± 0.14	± 1.05	± 0.10
E	79.5	2.65	3.06	3.39	3.99	7.20	4.20
	± 2.06	± 0.07	± 0.02	± 0.03	± 0.16	± 1.56	± 0.17
					***	**	**
<i>Agrostis tenuis</i> , L.							
C	81.50	2.79	2.94	3.13	5.06	13.45	6.05
	± 2.50	± 0.37	± 0.22	± 0.14	± 0.12	± 1.57	± 0.31
E	85.50	2.37	3.00	3.48	4.21	5.85	4.39
	± 4.27	± 0.32	± 0.21	± 0.13	± 0.08	± 1.56	± 0.23
					***	**	***

($\bar{x} \pm SEM$): mean and their standard error. C (Control): seeds irrigated with distilled water; E (Experimental): seeds irrigated with recycling waste water. G_{max} : percentage of germinated seeds (%); MGT: Mean germination time, T₁, T₁₀, T₂₅, T₅₀ and T₇₅; time needed to obtain 1, 10, 25, 50, 75% of seeds to germinate in days. Asterisks indicate differences vs. control: *** (0.001 < p < 0.01): strongly significant; ** (0.01 < p < 0.05): significant.

The evaluated parameters for both seeds irrigated with recycled waste water were below the control seeds parameters. These reductions involve that germination rate was increased. Results obtained for *F. arundinacea* (Sch) seeds show that T₅₀ (time needed to obtain 50% of germinated seeds) is 3.99 days for seeds irrigated with recycling waste water vs. 4.42 days for control seeds; statistical analysis reveals that this reduction is strongly significant. The mean germination time were also reduced. Results obtained for *Agrostis tenuis*, L seeds showed that T₅₀ (time needed to obtain 50% of germinated seeds) was 5.06 days for seeds irrigated with recycling waste water vs. 4.21 days for control seeds; statistical analysis reveals that this reduction is strongly significant. Parameter T₇₅ (time needed to obtain 75% of germinated seeds) was 5.85 days for experimental seeds in front of 13.45 days for control seeds. The mean germination time were reduced from 6.05 days for experimental seeds to 4.39 for control seeds.

Figure 1 shows the differences between the experimental and control germination curves of *F. arundinacea* (Sch) (a) and *Agrostis tenuis*, L seeds (b). Control curves are below experimental curves in both figures. The germination process when seeds have been irrigated with recycling water is better than control ones. Consequently, the recycling water from wastewater could be used to irrigate grass seeds in green areas. This application allows the economical resources generated by creation of green areas that do not require supplementary water supply. Results are according with reported by Hidalgo and Irusta, 2004, the wastewater has a high content of nutrients which provide an increase in yield without the use of fertilizers.

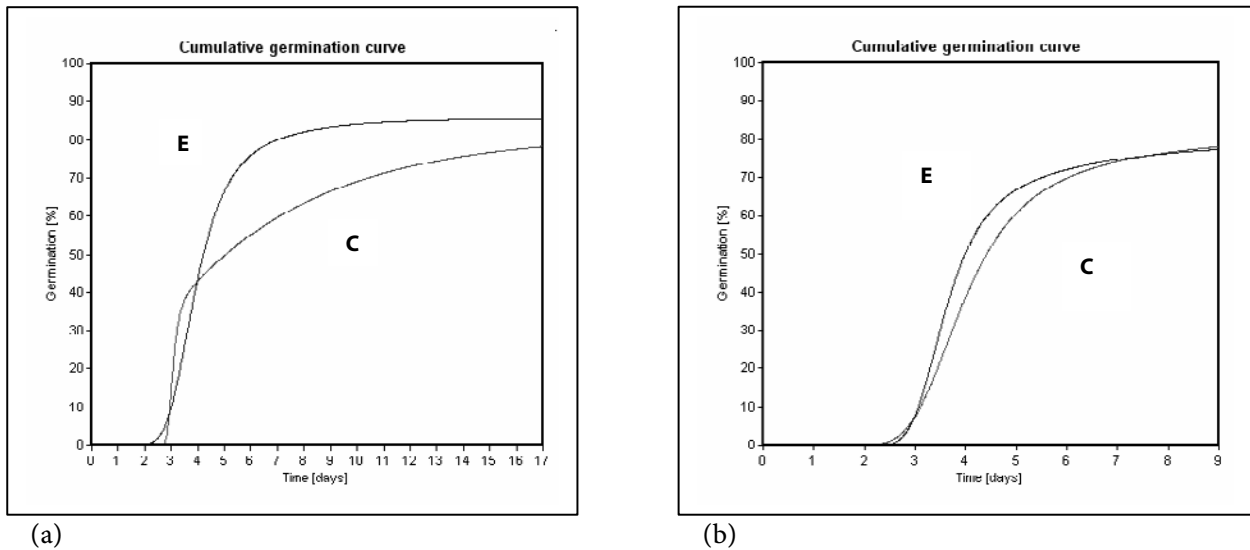


Figure 1.
Cumulative germination curves plotted for *Festuca arundinacea*
(a) and *Agrostis tenuis*, L. seeds
(b). E: experimental group, residual water; C: control group, distilled water

Conclusion

Recycling waste water could be used for irrigation of grass seeds *Festuca arundinacea*, Sch. and *Agrostis tenuis*, L. because produces a beneficial effect in germination rate and percentage. The recycling waste water irrigation allows save water and fertilizers and consequently to protect the environment.

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