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Influence of irrigation with wastewater of a leaven factory on grain yield and yield components of corn

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Abstract

In recent decades, water deficit and environmental hazards of wastewater have promoted the development of wastewater reuse in irrigation of agricultural lands in many arid and semi-arid regions. An experiment was conducted out at the experimental farm of a leaven factory (Iran Mayeh Co.), where the effect of treated wastewater was evaluated on yield and yield components of corn (*Zea mays*) during the growing season of 2012. Three, irrigation levels (I_1: irrigation with wastewater once in whole experimental period, I_2: irrigation with wastewater twice in whole experimental period, I_3: irrigation with wastewater in whole experimental period) and six wastewater percentage levels (C_1: 15% wastewater, C_2: 30% wastewater, C_3: 45% wastewater, C_4: 60% wastewater, A: pure water and P: pure wastewater) were studied in a factorial experiment on the bases of randomized complete block design with three replications. Results illustrated that number of irrigations with wastewater did not have significant effect on number of grain per ear, whereas it had significant effect on grain weight per ear, 1000-seeds weight, ear weight and grain yield. Also results showed that wastewater percentage did not have significant effect on mentioned traits. The maximum increase of grain yield was observed in irrigation with wastewater whole over growing season. Results also illustrated that irrigation with wastewater whole over the growth period had the most significant effect on yield components. Therefore, it seems that after assessing the effects of wastewater on soil and environment, the wastewater of this leaven factory can be used in corn irrigation.

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Introduction

The demand for water is continuously increasing in arid and semi-arid countries. Therefore, water of higher quality is preserved for domestic use while that of lower quality is recommended for irrigation. Municipal wastewater is less expensive and considered an attractive source for irrigation in these countries (Al-Rashed and Sherif, 2000). Yaryan (2000) studied the effects of irrigation with treated wastewater, well water and irrigation systems on the yield of sugar beet, corn and sunflower and properties of soil. Who obtained that the yield of sunflower and corn was higher under wastewater treatment, compared to well water treatment. However, the differences were not statistically significant. Wastewater treatment increased pH, available N, P, K, Mn, Pb, Ni and Co, but EC_e was decreased significantly.

Wastewater and agriculture are two sectors where the economic and environmental benefits of joint water management have been demonstrated through case studies around the world. It has been shown that the nutrients embodied in wastewater can increase yield as much or more than a combination of tap water and chemical fertilizer (Lopez *et al.*, 2006; WHO, 2006; Kiziloglu *et al.*, 2007). Kiziloglu et al (2008) showed that wastewater irrigation affects significantly soil chemical characteristics and nutrient content of cauliflower and red cabbage. Also soil salinity, organic matter, available P and microelements increased as influenced by wastewater treatment.

Erfani et al. (2001) showed that utilization of treated municipal wastewater has caused an increase in forage yield and whole plant dry matters as compared to irrigation with the well water. Tavassoli et al. (2010) to evaluate the effects of municipal wastewater with manure and chemical fertilizer on yield and quality characteristics of corn forage reported that irrigation with wastewater will increase forage yield.

As Iran located in a semi arid region, providing new resources of irrigation is very important. Therefore the objective of this study was assessing the impacts of irrigation with leaven factory wastewater on grain yield and yield components of Corn.

Materials and methods

This study was conducted at the experimental farm of Iran Mayeh Co. a leaven factory where is located at Tabriz (46° 21′ N, 38° 09′ E) during 2012 growing season. The experiment was carried out as a factorial based on complete block design with three replications. The treatments were three levels of number of irrigation (I_1: irrigation with wastewater once in whole experimental period, I_2: irrigation with wastewater twice in whole experimental period, I_3: irrigation with wastewater in whole experimental period) and six levels of wastewater percentage (C_1: 15% wastewater, C_2: 30% wastewater, C_3: 45% wastewater, C_4: 60% wastewater, A: pure water and P: pure wastewater). The soil characteristics are given in Table 1.

Table 1. Soil properties measured prior to the initiation of the experiment

Depth (cm)	Soil texture	pH	EC ($dS\ m^{-1}$)	OM
0-30	Sandy-Loam	7.31	0.98	2.64%

Experimental plots were sown with hybrid corn KoSc 504 cultivar at 10 plants per square meter with 50 cm row spacing and 20 cm between plants in rows. Analytical data of the treated wastewater and well water are shown in table 2. Irrigation was applied during growing season according to treatments.

Table 2. Chemical characteristics of treated leaven factory wastewater and well water

Fe(mg/l)	Zn(mg/l)	K(meq/l)	P(mg/l)	pH	EC(dS/m)	Wastewater percentage	Well water percentage
0.375	0.146	0.146	0	7.62	0.63	0%	100%
0.706	0.158	3.02	8.46	8.65	1.6	15%	85%
1.043	0.148	6.9	20.5	8.14	2.76	30%	70%
1.669	0.121	9.61	36.9	8.22	3.98	45%	55%
2.248	0.107	13.33	54.9	8.49	5.15	60%	40%
2.578	0.097	21.3	144	6.26	7.94	100%	0%

Crop sampling and calculation

Plants in four central rows at each plot were harvested to determine the grain yield in November 2011. The yield components included ear weight, 1000-seeds weight, grain weight per ear and number of grain per ear were obtained from five selected plants in each plot.

Statistical analysis

Data analyzed was done by MSTAT-C software. The ANOVA test was used to determine significant ($p<0.05$) treatment effect and Duncan Multiple Range Test to determine significant difference between individual means.

Results and discussion

Results of this study showed that number of irrigations with wastewater had significant effect on ear weight, grain weight per ear, 1000-seeds weight and grain yield of corn (Table 3).

The effect of wastewater percentage and interaction of number of irrigations with wastewater and wastewater percentage were not significant on ear weight, number of grain per ear, grain weight per ear, 1000-seeds weight and grain yield of corn (Table 3).

Table 3. Analysis of variance of grain specifications as affected by number of irrigations with wastewater and wastewater percentage treatments

S.O.V	df	Ear weight	Number of grains per ear	Grain weight per ear	1000-seeds weight	Grain yield
Replication	2	5524.950^{**}	39447.686^{*}	4647.503^{**}	2790.145^{*}	11618795.945^{**}
Number of irrigation with wastewater (A)	2	4779.755^{**}	9856.158^{ns}	3207.920^{**}	4538.828^{**}	8019688.320^{**}
Wastewater percentage (B)	5	638.359^{ns}	7108.229^{ns}	442.506^{ns}	648.035^{ns}	1106264.621^{ns}
Number of irrigation × wastewater percentage (A×B)	10	1350.045^{ns}	8669.990^{ns}	739.994^{ns}	488.038^{ns}	1850007.558^{ns}
Error	34	852.541	9224.318	514.659	722.094	1286647.299
CV (%)		19.23	17.04	19.18	12.82	19.18

Ns: Non significant; **, *: significant at 1% and 5% probability

Ear weight

The highest ear weight was obtained from irrigation with wastewater in whole experimental period and the lowest ear weight obtained from irrigation with wastewater once in whole experimental period (Fig. 1). One of the most important parameters in cotton yield is the number of bolls per plant and per square meter. Irrigation with wastewater had a

significant effect on the number of bolls per square meter. So the number of bolls became greater with increasing the level of wastewater (Alikhasi et al. 2012).

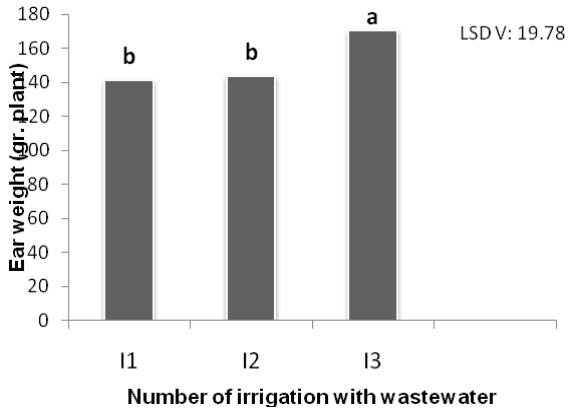

Fig. 1. Effect of number of irrigation with wastewater treatment on ear weight. Different letters expose significant difference at 5% probability

Grain weight

According to means comparing recognized that the use of irrigation with wastewater in whole experimental period in comparison with irrigation with wastewater once and twice in whole experimental period, result in the increase of grain weight per ear (Fig. 2).

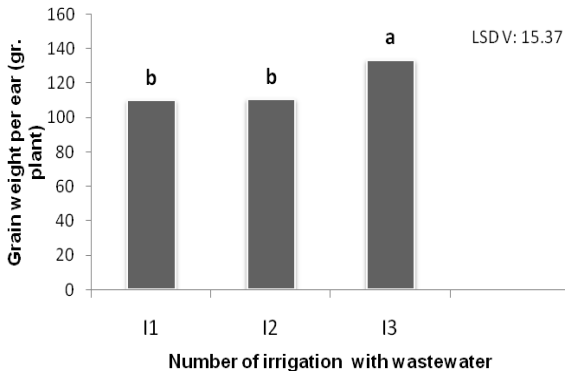

Fig. 2. Effect of number of irrigation with wastewater treatment on grain weight per ear. Different letters expose significant difference at 5% probability

1000-seeds weight

Among number of irrigations with wastewater treatments, irrigation with wastewater in whole experimental period showed the highest 1000-seed weight and the lowest 1000-seed weight obtained from irrigation with wastewater once in whole experimental period (Fig. 3). Mohamad and Ayadi (2004) reported that grain weight of corn was increased significantly by wastewater irrigation compared to pure water irrigation.

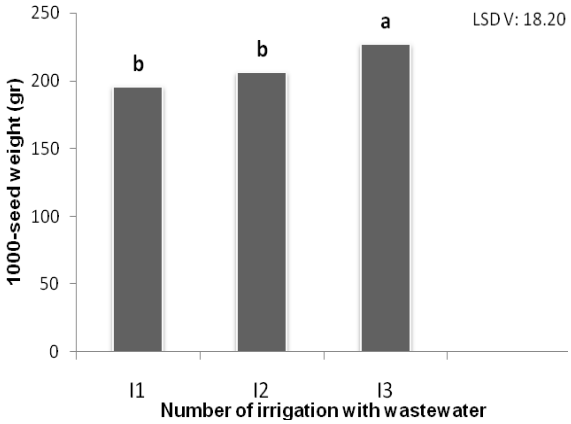

Fig. 3. Effect of number of irrigation with wastewater treatment on 1000-seed weight. Different letters expose significant difference at 5% probability

Grain yield

The grain yield of those treatments which used irrigation with wastewater in whole experimental period was higher than treatments which used irrigation with wastewater once in whole experimental period and irrigation with wastewater twice in whole experimental period (Fig. 4). Similar results were reported by Erfani et al (2001). Similar results were reported by Day et al. (1979) who observed that wheat irrigated with wastewater produced taller plants, more heads per unit area, heavier seeds, higher grain yield than did wheat grown with pump water alone. They attributed this increase to the nitrogen, phosphorous, potassium and another nutrient elements which added by wastewater to the soil.

Conclusion

The results in this experiment showed that irrigation with wastewater in whole experimental period significantly increased grain yield, 1000-seeds weight and ear weight but it did not have significant effect on number of grain per ear, so we came to conclusion that 1000-seeds weight and ear weight caused higher grain yield.

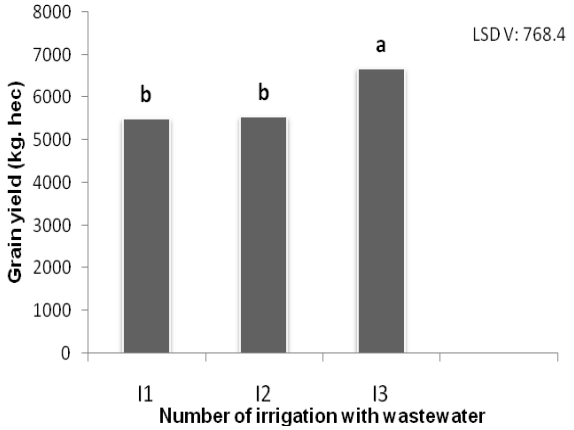

Fig. 4. Effect of number of irrigation with wastewater treatment on grain yield. Different letters expose significant difference at 5% probability

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