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Influence of irrigation with wastewater of leaven factory on grain and ear characteristics of corn

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Abstract

In recent years, 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, where the effect of treated wastewater on yield and yield components of corn (*Zea mays*) was studied 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 and 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 randomized complete block factorial design with three replications. Results illustrated that number of irrigation with wastewater did not have significant effect on grain characteristics, row per ear and ear length while it had significant effect on ear diameter, cob weight, total weight of grain and cob. Also results showed that wastewater percentage did not have significant effect on mentioned traits. The maximum increase of total weight of cob and grain was observed in irrigation with wastewater whole over growth season. Results also illustrated that irrigation with wastewater whole over the growth season had the most significant effect on ear diagonal and harvest index.

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Introduction

Water resources are steadily declining in arid and semi-arid regions where corn is among the most important crops. Municipal wastewater could be an important alternative source for irrigation. The use of wastewater for irrigation has the additional benefit of environmental protection (Pescod, 1992). Wastewater is recognized to have direct effect on soil chemical parameters. It affects availability of macro and micro nutrients for plant growth and changes pH, buffer capacity and CEC of the soil. Wastewater may also contain significant quantities of toxic metals and therefore its long-term application may due to accumulation of heavy metals in toxic values with unfavorable effects on plant growth (Rattan *et al.* 2005).

Several studies have been carried out to investigate the effects of municipal wastewater on agroecosystems. 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 decreased significantly.

Kiziloglu *et al* (2008) showed that wastewater irrigation affected significantly soil chemical characteristics and nutrient content of cauliflower and red cabbage. Also soil salinity, organic mater, available P and microelements increased as influenced by wastewater treatment. Day, *et al* (1979) compared the effect of irrigation with wastewater than pump water on wheat. They concluded that wastewater irrigation produced taller plants, more heads per unit area, heavier seeds and higher grain yields than pump water.

Almasi *et al* reported that irrigation with wastewater did not have significant effect on 1000-seeds weight and grain yield .As Iran located in semi arid region, providing new resources of irrigation is very important. The objective of this study was assessing the impacts of leaven factory wastewater irrigation on grain and ear characteristics and 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). A field experimental was conducted 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).

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 row spacing. Analytical data of the treated wastewater and well water are shown in table 1. Irrigation was applied during growing season according to treatments.

Crop sampling and calculation

Plants in four central rows at each experimental plot were harvested to determine the grain yield in November 2011. The yield components included rows per ear, grain weight plus cob weight, ear diameter and other traits included grain characteristics, ear length, cob weight and harvest index were obtained from five selected plants in each experimental 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

Data presented at table 2 indicated that number of irrigation with wastewater and wastewater percentage had not significant effect on grain characteristics.

Data cited in table 3 show significant effect due to number of irrigation with wastewater on ear diameter, cob weight, total weight of grain and cob and harvest index of corn.

Table 1. 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%

Table 2. Analysis of variance of grain specifications as affected by number of irrigation with wastewater and wastewater percentage treatments.

S.O.V	df	Grain length	Grain width	Grain thickness
Replication	2	0.022^{**}	0.002^{ns}	0.004^{ns}
Number of irrigation with wastewater (A)	2	0.004^{ns}	0.0003^{ns}	0.001^{ns}
Wastewater percentage (B)	5	0.003^{ns}	0.002^{ns}	0.006^{ns}
Number of irrigation × wastewater percentage (A×B)	10	0.004^{ns}	0.001^{ns}	0.003^{ns}
Error	34	0.004	0.002	0.005
CV (%)		5.32	7.39	16.62

Ns: Non significant; **: significant at 1% probability.

Results also indicated that ear diameter, cob weight, total weight of grain and cob and harvest index did not respond to wastewater percentage, significantly (Table 3). The number of irrigation with wastewater × wastewater percentage only at the cob weight was significant (Table 3). Significantly higher grain and straw yield was recorded due to application of domestic wastewater over ground water irrigation. The domestic wastewater contains large amount of nutrients and therefore could be used as source of irrigation (Maiti *et al.* 1992).

Table 3. Analysis of variance of ear specifications and harvest index as affected by number of irrigation with wastewater and wastewater percentage treatments

S.O.V	df	Ear diameter	Ear length	Cob weight	Row per ear	Total weight of grain and cob	Harvest index
Replication	2	0.102^{ns}	66.488^{**}	186.205^{**}	4.179^{**}	5473.435^{**}	208.386^{**}
Number of irrigation with wastewater (A)	2	0.220^{*}	8.739^{ns}	122.723^{*}	0.175^{ns}	4575.120^{**}	137.681^{**}
Wastewater percentage (B)	5	0.011^{ns}	5.593^{ns}	25.195^{ns}	0.118^{ns}	621.992^{ns}	37.110^{ns}
Number of irrigation × wastewater percentage (A×B)	10	0.082^{ns}	7.732^{ns}	66.594^{*}	1.200^{ns}	1190.384^{ns}	31.365^{ns}
Error	34	0.053	6.069	30.139	0.768	795.554	25.534
CV (%)		4.98	17.58	24.85	4.4	19.92	10.59

Ns: Non significant; * and **: significant at 5% and 1% probability Ear diameter.

The ear diameter of those treatments which used irrigation with wastewater in whole experimental period was higher than treatments which used irrigation with wastewater once and twice in whole experimental period (Fig 1). Zheng *et al* (2000), found that adequate supply of organic wastes with chemical fertilizers improve the wheat crop properties.

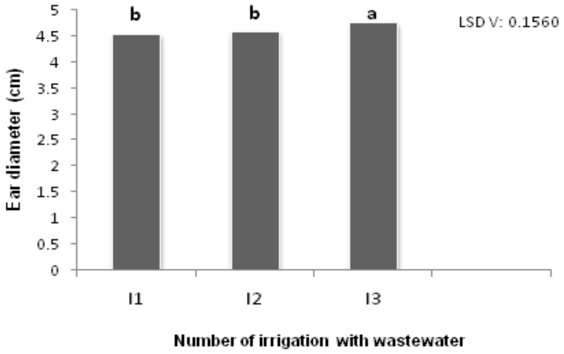

Fig. 1. Effect of number of irrigation with wastewater treatment on ear diameter. Different letters expose significant difference at 5% probability.

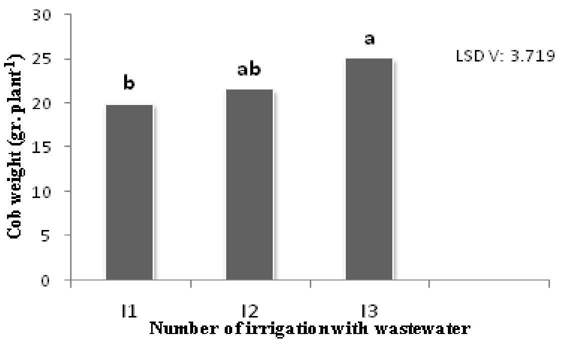

Fig. 2. Effect of number of irrigation with wastewater on cob weight. Different letters expose significant difference at 5% probability.

Cob weight

The maximum of cob weight was observed in irrigation with wastewater in whole experimental period and the minimum of cob weight was observed in irrigation with wastewater once in whole experimental period (Fig. 2).

The highest cob weight obtained from irrigation with wastewater in whole experimental period × 30% wastewater treatment and it increased cob weight 34.47% than pure water and the lowest cob weight obtained from irrigation with wastewater once in whole experimental period × 30% wastewater. It decreased cob weight 58.11% than pure water (Fig. 3). The primary yield components of corn are biological yield, 1000-seed weight, number of seed per ear, row per ear, ear diameter and ear length. Even though, yield components are under genetic control, they do respond with various degree of flexibility to water deficit or irrigation regime (Nabipour *et al.* 2007).

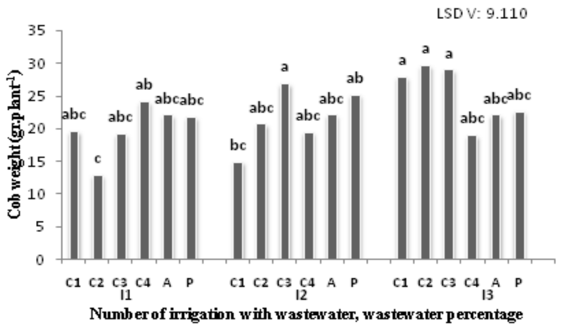

Fig. 3. The interaction effects of number of irrigation with wastewater and wastewater percentage on cob weight. Different letters expose significant difference at 5% probability.

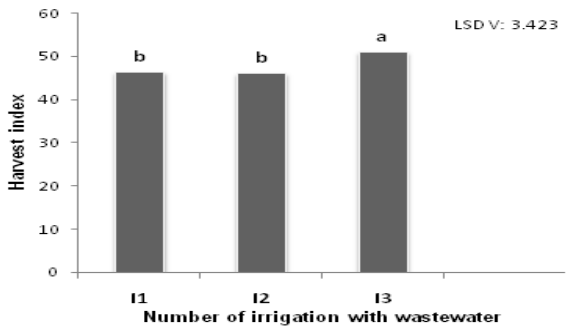

Fig. 4. Effect of number of irrigation with wastewater on harvest index. Different letters expose significant difference at 5% probability.

Harvest index

Among all number of irrigation with wastewater treatments, irrigation with wastewater in whole experimental period had the highest and irrigation with wastewater twice in whole experimental period had the lowest effect on harvest index of corn (Fig 4). Tavassoli *et al.* (2010) reported that irrigation with wastewater caused increasing the grain yield in corn.

Conclutions

Study data demonstrated that corn yield components of KoSc 504 cultivar can be increased by application of wastewater and combination of irrigation with wastewater in whole experimental period and 30% wastewater was the most effective treatment.

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