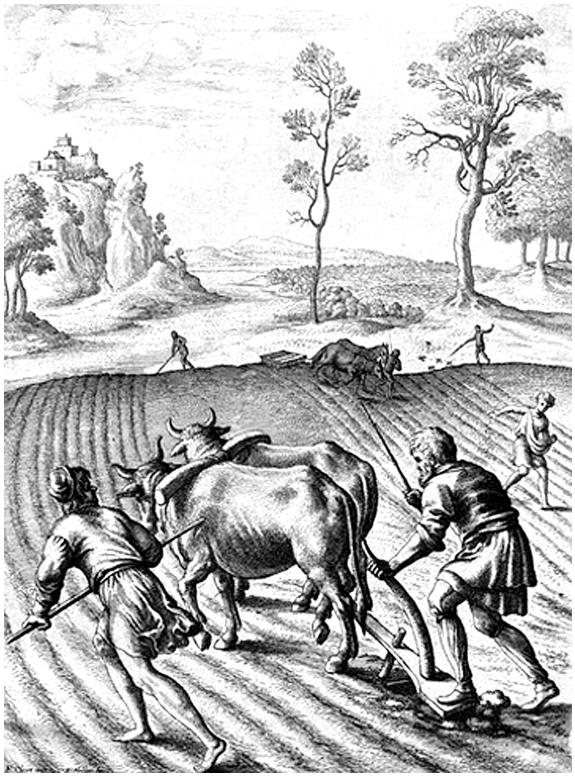
ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY



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Journal of Agronomy 7 (3): 277-280, 2008
ISSN 1812-5379

Effect of Municipal Wastewater with Manure and Chemical Fertilizer on Grain Yield and Yield Components in Corn KoSc 704

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Abstract: In order to study effects of wastewater with two kind of fertilizers (manure and chemical fertilizer) on grain yield and yield components in corn (KoSc 704) a field experimental was conducted at the university of Zabol in Iran during 2007 growing season. The experiment was conducted as split block design with three replications. The treatments were comprised of two levels of irrigation water (W_1 = well water and W_2 = wasetewater) in main plot and five levels of fertilizer (F_1 = control, F_2 = manure: 30 ton ha^{-1}, F_3 = manure: 15 ton ha^{-1}, F_4 = NPK: 350, 200 and 100 kg ha^{-1} and F_5 = NPK: 175, 100 and 50 kg ha^{-1}) in sub plot. Results showed irrigation with wastewater significantly increased grain yield of corn than usual water. Also, wastewater had positive significantly influence on grain yield and all yield components, but the most effective of wastewater on yield components was on the 1000-seed weight. Among the fertilizer, F_4 in all situations had the most effective on the grain yield and yield components and increased them.

Key words: Municipal wastewater, manure, chemical fertilizer, yield, corn

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).

Agricultural and landscape irrigation can offer significant opportunity for reuse, in arid and semi-arid regions, since 70 to 90% of water resources are used for irrigation (Shelef and Azov, 1995). Wastewater is recognized to have direct effect on soil chemical properties. When wastewater will be used continuously as the sole source of irrigation water for field crops, excessive amounts of nutrients and toxic chemical substances could, simultaneously, be applied to the soil-plant system. This would cause unfavorable effects on productivity and quality parameters of the crops and the soil (Vazquezmontiel *et al*., 1996).

Soil quality degradation by wastewater is particularly important in regions, where, there is low input of organic matter. Although, information on the effect of animal manure and other organic fertilizers on crop yield are available, farmers in the region rely on chemical fertilisers to maintain crop yield and pay little attention to maintaining soil Organic Matter (OM) in soils. Chemical fertilizers are significant to source nutrient in soil.

Heavy doses of chemical fertilizers are commonly used in order to enhance corn yields. Approximately, 50% of crop yield increment has been promoted by chemical fertilizers (FAO, 1989).

The objective of this study was to determine the possibility of reusing the municipal wastewater and the effect of it with two kind of fertilizers (manure and chemical fertilizer) on grain yield, biomass and yield components in corn.

MATERIALS AND METHODS

This study was conducted at the experimental farm of the Department of Agronomy and Crop Breeding Faculty of Agriculture University of Zabol (61° 29 ' N, 31° 2' E). The site has an arid climate and is 483 m above sea level. Mean annual precipitation and temperature are 85 mm and 16.5°C, respectively. The soil (sandy-loam) properties prior to the experiment are shown in Table 1.

Experimental procedures: A field experimental was conducted at the University of Zabol in Iran during 2007 growing season. The experiment was conducted as split block design with three replications. The treatments were

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

Depth (cm)	Soil texture	pH	EC (dS m^{-1})	OM (g kg^{-1})
0-30	Sandy-Loam	7.4	1/8	2/3

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comprised of two levels of irrigation water (W_1 = well water and W_2 = wasetewater) in main plot and five levels of fertilizer (F_1 = contro, F_2 = manure: 30 ton ha^{-1}, F_3 = manure: 15 ton ha^{-1}, F_4 = NPK: 350, 200 and 100 kg ha^{-1} and F_5 = NPK: 175, 100 and 50 kg ha^{-1}) in sub plot.

The average values of physical and chemical characteristics of the treated wastewater are reported in Table 2. In this study total manure to both irrigation were applied prior sowing and for chemical fertilizer, $^1/_2$ N and total P and K fertilizers were applied prior the sowing seeds.

Experimental plots were seeded with hybrid corn KoSc 704 at 30 kg ha^{-1} with 70 cm row to row distance and 22 cm between plants. Corn was planted manually using two seeds per hole in June 2007. After crop establishment, thinning was done maintaining one plant per hill. Irrigation was applied as required during the growing season. The corn was harvested in November 2007. Data collected included yield (obtained by combining the five center rows at each experimental unit), biological yield or dry weight were measured after drying samples at 70°C for 48 h in an air oven (Schuurman and Goedewaagen, 1971; Veli *et al*., 1991) and plant height. The yield components included 1000-seed weight, number of seed per year, row per ear, ear diameter and ear length were obtained from six selected plants in each experimental unit.

Table 2: Selected properties of the treated wastewater

Parameters	Values
pH	7.900
EC (dS m^{-1})	3.200
N (mg L^{-1})	23.120
P (mg L^{-1})	11.100
K (mg L^{-1})	25.600
SAR (mg L^{-1})	3.800
Zn (mg L^{-1})	0.015
Cu (mg L^{-1})	0.010
Mn (mg L^{-1})	0.050

Statistical analysis: All data were analyzed with SAS Institute Inc. 6.12. All data were first analyzed by NOVA to determine significant ($p \leq 0.05$) treatment effects. Significant differences between individual means were determined using grouped in Duncan Multiple Comparison Test.

RESULTS AND DISCUSSION

Grain yield: Results of this study showed wastewater had significantly effects on grain yield.

Compared to the control irrigation (where wastewater was never applied), wastewater induced 39.19% increase in the grain yield of corn (Table 3). 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 yields than did wheat grown with pump water alone. They attributed this increase to the nitrogen, phosphorus, potassium and another nutrient elements which added by wastewater to the soil.

However, wastewater has essential nutrient elements (Table 2) for plant functions, but these concentration of nutrients are not enough to plant production in this condition. Then plants need application another fertilizer, manure or chemical fertilizer. Mohammad Rusan *et al.* (2007) reported long period application of wastewater accumulate of salts and some nutrients and heavy metals in the soil. Accumulation of salts can cause reduction grain yield and plant biomass production.

Results of this study, showed application of fertilizer had significantly effects on the grain yield of corn (Table 3). Among the fertilizer treatments, F_4 (NPK: 350, 200 and 100 kg ha^{-1}) had the highest effects and 33.3% increased grain yield than F_1 (control) treatment (Table 3).

Interaction between fertilizer and irrigation had significantly effect on grain yield and among the

Table 3: Comparison of means for grain yield and yield components in corn

	Grain yield (g m^{-2})	Biomass	Row per ear (cm)	1000-seed weight	Seed per ear (g)	Ear diameter (cm)	Ear length
Irrigation							
W_1	426.3 b	2128.2b	12.6b	189.3b	23.6b	4.1b	11.5b
W_2	701.1a	2327.9a	13.6a	255.6a	26.7a	4.5a	12.7a
Fertilizer							
F_1	438.1c	212.3b	12.4c	194.6c	22.8b	3.9c	11.6a
F_2	593.9ab	2148.5b	12.9bc	226.3ab	24.1ab	4.3ab	12.2a
F_3	499.2b	2177.8b	12.4c	205.3bc	24.7ab	4.1bc	12.3a
F_4	657.2a	2414.6a	14.1a	248.7a	27.6a	4.4a	12.5a
F_5	630.2a	2279.2ab	13.8ab	237.5a	26.8a	4.4a	12.1a

In each column means with similar letter are not significant. W_1 = Well water, W_2 = wasetewater, F_1 = Contro, F_2 = Manure: 30 ton ha^{-1}, F_3 = Manure: 15 ton ha^{-1}, F_4 = NPK: 350, 200 and 100 kg ha^{-1} and F_5 = NPK: 175, 100 and 50 kg ha^{-1}

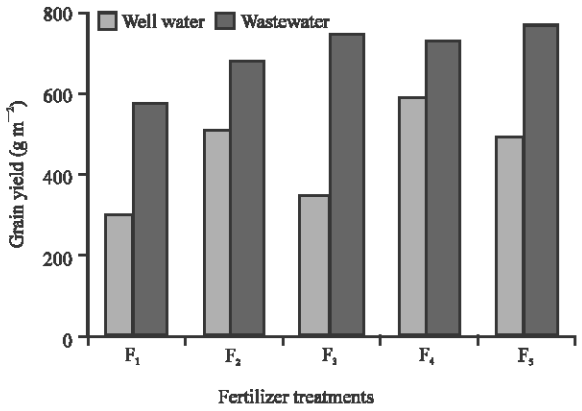

Fig. 1: Interaction between fertilizer and irrigation on grain yield

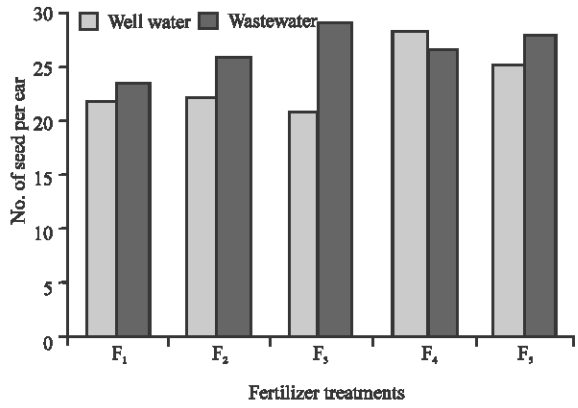

Fig. 2: Interaction between fertilizer and irrigation on seed per ear

treatments, W_2F_5 (wastewater and NPK: 175, 100 and 50 kg ha^{-1}) had the highest and W_1F_1 (well water and without fertilizer application) had the lowest effect (Fig. 1). In addition, wastewater is a valuable source of plant nutrients and organic matter needed for maintaining fertility and productivity levels of the soil (Weber *et al*., 1996). On the other hand, wastewater may contain undesirable chemical constituents and pathogen that pose negative effects on plant growth (Papadopolos, 1995).

In this condition application of manure or chemical fertilizer can help plant growth. In this study, it observed application chemical fertilizer had more positive effect than manure fertilizer on corn.

Yield components: 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). The analysis of variance indicates that application of wastewater had significantly effect on yield components in corn and biological yield, 1000-seed weight and other yield components, were significantly ($p<0.01$) higher under wasterwater as compared to well water (Table 3).

Several researchers reported accumulation of N, P and K in the soil with wastewater cause increasing biological yield and grain yield in crops (Monnett *et al*., 1996). In this study, among the yield components, wastewater had the most influence on the 1000-seed weight and increased it 25.9% than well water (Table 3).

One of the reasons of this increasing related to effects of wastewater on leaf chlorophyll content. Result, in this study, showed, wastewater (measured at the grain filling period) 22.5% increased leaf chlorophyll content than well water (Table 3). After 1000-seed weight, number of seed per ear (11.8%) ear length (9.4%), biological yield and ear diameter (8.6%) and row per ear (7.3%) had the highest increasing, respectively.

Fertilizer treatments, in this study, had significantly effect on yield components in corn (Table 3). Among the fertilizer treatments, F_4 (NPK: 350, 200 and 100 kg ha^{-1}) had the highest effect on the total yield components (Table 3). Marschner (1995) reported soil fertility is one of the important factors affecting crop production, by application chemical fertilizer number of seed production, 1000-seed weight and then grain yield of crops will increase.

Interaction between fertilizer and irrigation had significantly effect only on number of seed per ear and row per ear. Figure 2 shows that W_2F_3 (wastewater and manure: 15 ton ha^{-1}) treatment has the highest number of seed per ear. Min *et al*. (2003) reported manure has beneficial effects on soil quality properties than chemical fertilizers alone.

Organic sources such as animal manure can be an effective source of major nutrients (N, P and K) when applied at optimum rates and can influence the temporal dynamic of nutrient availability (Paul and Beauchamp, 1993), increase water use efficiency of crops (Carter *et al*., 1992) decrease soil P fixation and enhances P availability in soils (Iyamuremye and Dick, 1996) through its effect on physical and chemical properties of the soil. About row per ear, results in this study, shows

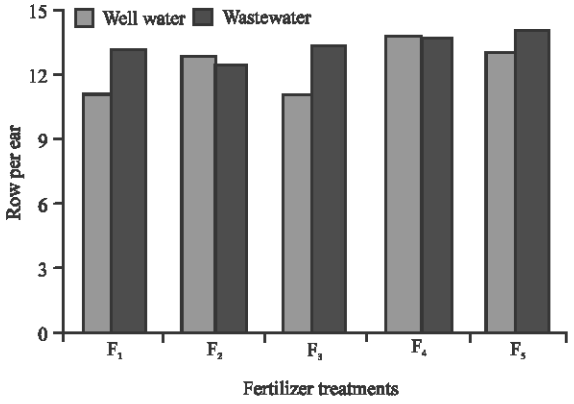

Fig. 3: Interaction between fertilizer and irrigation on row per ear

that W_2F_5 (wastewater and NPK: 175, 100 and 50 kg ha^{-1}) treatment has the highest amount (Fig. 3).

CONCLUSION

Study data demonstrated that corn yield of KoSc 704 cultivar can be increased by integrated application of wastewater and chemical fertilizer, which was a consequence of 1000-seed weight, number of seed per ear and biological yield (total dry matter production).

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