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Effect of Treated Municipal Wastewater on the Growth of Three Cultivars of Barely

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ABSTRACT

In order to study the effects of irrigation with municipal treated wastewater on the vegetative growth of three barley varieties, an experiment was conducted at the greenhouse of Yasouj Islamic azad University, in years 2010-2011. Three varieties of barley (Izeh, Mahoor, Makooei) with three level of irrigation (1.Irrigation with common water 2. Alternative irrigation with wastewater and common water 3. Irrigation with wastewater) were compared in a factorial experiment based on a completely randomized block with three replications per treatment. Bush height, number of tiller, number of leaf, width of leaf, length of leaf, dry weight of aerial organs, dry weight of root and density of heavy metal Zinc, Plumbago and Cadmium in aerial organs were recorded. Result of variance analysis showed that alternative irrigation had significant advantage on bush height, number of tiller, number of leaf, dry weight of aerial organs. Makooei under alternative irrigation had the longest bush height (82.33), the most number of tiller in bush (3.87), the most number of leaf in bush (8.89), the most dry weight of aerial organs in bush (2.82). there was no significant difference on width of leaf, length of leaf, dry weight of root. Makooei variety had more significant advantage than other varieties. At the present study, density of heavy metal (Zn, Pb, Cd) had no significant difference in aerial organs and pollution was not noticed.

KEY WORDS: Barley, municipal refined wastewater, vegetative growth, heavy

1. INTRODUCTION

The ever-increasing growth of world population, accompanied by the expansion of agricultural and industrial activities for providing food on the one hand, and successive draughts of recent years, on the other, have led to excessive use of freshwater resources in most countries located in dry areas and thereby, have exerted an excessive pressure on water resources (Arvandi & Moghadas, 2000). One of the solutions most countries, especially countries of the Middle East, have chosen to solve the problem of water shortage, is the use of unusual waters for the cases which do not require high quality water. 3 million hectares of lands surrounding cities in China, 340,000 hectares of such lands in Mexico, 61000 hectares of fields in Chile, and about 10000 hectares of lands neighboring Melbourne in Australia are irrigated using urban wastewater (Malakouti, 1994). Pscode (1992) states that the best way for disposing of wastewater after conventional processes of treatment is using it in agriculture (Pscode, 1992).

Household wastewater contains 99.9% water and 0.1% impurities including solid matters, colloids, and suspended solids. Gasses, microorganisms, and other matters also constitute a minor part of wastewater (Naddafi & Nabizadeh, 1996).

Wastewater contains three elements of N, P, and K as well as micronutrients necessary for plants growth. Presence of such elements in wastewater is considered as the advantages of using it in agriculture resulting in economical use of chemical fertilizers. The amount of nitrogen and potassium in wastewater usually meets the need of plants for these elements for growth and the amount of phosphorus is more than the need of plans which makes no harm. However, in some cases, the amount of N and K in wastewater is more than the needs of the plants causing overgrowth, delay in ripening the crops, and low quality of the crops (Al.Salem, 1998; Asano et al., 1996; Papadopoulos &Stylianon, 1998; Papadopoulos &Stylianon, 1991).

One advantage of irrigation with wastewater is that nutrients are gradually fed to the plant, while chemical fertilizers provide the plant with a plenty of nutrient elements all at once. A large part of nutrients, before being completely used by the plant, is removed through different ways. Also, intermittent distribution of fertilizers requires skillful personnel and equipments which raise production expenses (Malakouti, 1994).

In the Astaneh Guds Farm in Mashhad, Yaghmaee studied the effect of different percents wastewater on the performance of corn. The highest performance of corn and total biomass was observed in 100% treatment of municipal wastewater, and by decreasing the percent of wastewater, the performance also decreased. The amount of

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heavy metals in the soil and corn increased through irrigation with wastewater, but its value was below the permissible level. The percentage of protein in corn in wastewater treatment was higher than controls (Yaghmaee, 2000). Irrigation with wastewater significantly increases the height of plant and width of leaves in corn (Alizadeh et al., 2001).

A group of researchers conducted a study on the effect of treated municipal wastewater on the performance of wheat, barley, and triticale in Mashhad. They found that in the cultivars under study, by increasing wastewater by 50%, the performance of grains increases significantly but does not change in higher percents. The highest performance was observed in triticale. With respect to grain weight, although no significant increase was observed in the mean scores, the highest weight was found in barley and triticale. The biological performance of all three plants increased significantly (Feizi & Rezvani Moghadam, 1999).

Irrigation of lettuce with wastewater indicated that the weight of aboveground organs, underground organs, and total dry and wet matter of the plant significantly increased following treatment with treated municipal wastewater. Also, this study revealed that the density of macro-nutrients in the treatment group was higher than the control group. Also, plants irrigated by wastewater and treated with animal manure reached flowering stage earlier than other treatments (Erfani et al., 2002).

Throughout 8 years of irrigation with wastewater, the amount of iron and magnesium in corn, manganese and zinc in wheat grain and straw, zinc and copper in the leaves and stem of tomato, and the amount of iron, zinc and copper in tomato fruit planted in such fields was significantly more than fields irrigated with ordinary water. At the same time, irrigation with wastewater did not result in the increase in density of elements in the leaves and stem of alfalfa. In general, the density of heavy elements in the soil and plants was less than critical value and was not dangerous (Feizi, 2001).

The distribution and accumulation of heavy elements among plant organs is very important, as it is not homogenous in different organs. Usually, they are accumulated less in the grain and fruit of the plant than its leaves and root (Taee Samiromi, 2005). The movement of heavy elements in plants depends on the type of element, plant organ, and its age (Vaseghi et al., 2001). Cadmium has the highest and lead has the lowest level of movement after absorption in lettuce (Kabata-pendias et al., 1992). The findings of some studies refer to accumulation of iron, copper and zinc in the root compared to aboveground organs of plant following irrigation with wastewater (Zolfagharan, 2001; Feizi, 2001).

The aim of the present study is to investigate the effect of irrigation with different rations of municipal wastewater on growth of three barley cultivars and accumulation of lead and cadmium in aboveground organs.

2. MATERIALS AND METHODS

The experiment was conducted in the greenhouse of Islamic Azad University, Yasooj branch, located in Belahzar village in 89-90 agricultural year. Different ratios of irrigation water using ordinary water and treated municipal wastewater were studied on three cultivars of barley. The treatments involved different percents of wastewater as 0-1 (irrigation with ordinary water), 2-50 (intermittent irrigation with wastewater and ordinary water), 3-100 (irrigation with wastewater) and three cultivars of barley (Izeh, Mahoor, and Makoee). The experiment was conducted as 3 × 3 factorial with a randomized block design with three replications. The wastewater used was prepared from Yasooj municipal wastewater treatment plant. The results of chemical analysis of the wastewater are presented in Table 1. Each treatment involved a pot with diameter of 22 cm and height of 25 cm filled with 5 Kg soil. In order to prevent soil wash, glass wool was placed at the bottom of each pot, and a mat was used for each pot so that the excess water coming out of the pot can be returned to it. In each pot, 30 barley seeds were planted in the depth of 3 cm. The pots were labeled and 27 pots were placed in the greenhouse so that they had similar conditions in terms of environmental factors (light and heat). The experiment started in Aban. At first, all pots were irrigated with ordinary water, and after germination and establishment (two-leaf stage) treatments of wastewater were applied. Irrigation with wastewater was done two times a week in equal amounts. In three-leaf stage, 15 equal plants were kept in each phase and the rest were removed. Also, in order to investigate the effect of nutrients contained in wastewater on plant growth, no fertilizer was utilized. Throughout the experiment, the height of plant, number of tillers, and number of leaves were noted. After cutting aboveground organs, separate tissues of each treatment were dried in room temperature for one week and then were weighted. The density of heavy elements like lead and cadmium in aboveground organs was calculated using dry ashing method and atomic absorption apparatus. The obtained data were analyzed by SAS software and the means were compared using Duncan test. To draw tables, Word application, and for drawing charts, excel were used.

3. RESULTS AND DISCUSSION

The Height of Plant

Irrigation with wastewater significantly increased plant height in three cultivars of barley, and the highest plant in three cultivars was obtained through intermittent irrigation (50% wastewater). The heights of Izeh, Mahoor, and Makoee cultivars in intermittent irrigation were respectively 75, 76.66, and 82.33 cm. It seems that the nitrogen contained in wastewater up to 50% meets the need of plant to nitrogen. Alizadeh et al. (2001) obtained similar results on corn.

Number of tillers in the plant

Analysis of variances revealed that irrigation with wastewater in 1% level has significant impact on the number of tillers in the plant. In all three cultivars of barley, the highest number of tillers belonged to intermittent irrigation and was observed with the mean of 3.84 tillers in a plant in Makoee cultivar. The lowest number of tillers with mean of 2.65 tillers in plant belonged to Mahoor cultivars under ordinary irrigation. Ghanbari et al. (2006) found similar results in wheat.

Number of leaves in plant

Irrigation with wastewater significantly increased the number of leaves in plant in three cultivars of barley. According to comparison of means (Table 2), the highest number of leaves in plant was obtained through intermittent irrigation (50% wastewater). Probably, the nutrients of wastewater up to 50%, meets the needs of plant for growth and higher levels does not have any impact on the growth of barley. Among three cultivars studied, Makoee showed the best reaction with highest number of leaves in intermittent irrigation (mean= 8.89).

Dry weight of aboveground organ per plant

Dry weight of aboveground organ increased significantly by increasing wastewater to 50% (intermittent irrigation of wastewater and ordinary water) which is due to increase in plant growth and height. The highest level of reaction was observed in Makoee cultivar which was 2.82 g in intermittent irrigation and 2.37 in wastewater irrigation showing 47 and 2 percent increase relative to controls.

Feizi et al. (2008) found that using wastewater in irrigation of barley, wheat and triticale significantly affects the performance of forage. They obtained the best level in intermittent irrigation with wastewater (50%).

Heavy elements

Analysis of variance revealed that irrigation with wastewater does not have significant effect on the accumulation of heavy elements in aboveground organs. The findings of this study indicated that wastewater can substitute ordinary water provided that its level does not exceed 50% of irrigation water. Also, Makoee cultivar adapts well to this kind of irrigation with wastewater compared to Mahoor and Izeh cultivars.

4. Conclusion

A – Irrigation treatment has significant impact on plant height, number of tillers, number of leaves, and dry weight of aboveground organs. In these parameters, intermittent irrigation was more effective.

B- Different cultivars of barley did not show similar patterns of growth when treated with wastewater. Makoee cultivar showed better results relative to Izeh and Mahoor cultivars.

C- Irrigation with wastewater did not have significant effect on accumulation of zinc, lead, and cadmium in aboveground organs of barley.

5. Tables

Table 1. The Results of Chemical Analysis of Treated Municipal Wastewater

Ec	*pH*	*Nitrogen (ppm)*	*Potassium (ppm)*	*Zinc (ppm)*	*Lead (ppm)*	*Cadmium* (ppm)
5/5	7/33	14	0/03	0/02	0/02	0/01

Table 2. Comparison of Means of Mutual Effect of Cultivars and Irrigation of Significant Features

Variety	*Irrigation*	*Plant height*	*Number of leaves*	*Number of tillers*	Dry Weight of aboveground organ
Izeh	Ordinary	60.00 d	6.02 c	2.82 d	**1.83 c**
	Intermittent	75.00 b	7.766 b	3.53 b	**2.29 b**
	Wastewater	70.00 c	7.42 b	3.25 c	**2.13 b**
Mahoor	Ordinary	56.33 d	5.97 c	2.65 d	**1.72 c**
	Intermittent	76.66 ab	8.12 a	3.61 ab	**2.30 b**
	Wastewater	71.00 bc	7.52 b	3.31 bc	**2.16 b**
Makoee	Ordinary	65.00 cd	7.22 b	3.13 c	**1.91 c**
	Intermittent	82.33 a	8.89 a	3.87 a	**2.82 a**
	Wastewater	**75.00 b**	**7.97 ab**	**3.53 b**	**2.37 b**

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