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Effect of different irrigation times and wastewater of a leaven factory on yield, yield components and harvest index of faba bean(*Vicia faba* L.)

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Abstract

In order to suitable use of wastewater in sustainable agriculture a field study was carried out at the field of Iran Mayeh factory located at Gharamalek region of Tabriz, Iran. Experiment was arranged in factorial based on randomize complete block design (RCBD) in three replications during the spring of 2012. In this study the effects of irrigation times and wastewater concentration on yield, yield components and harvest index were evaluated. Experimental factors were irrigation times in three levels (I_1= one time irrigation with determined concentration of wastewater, I_2= twice irrigation with determined concentration of wastewater, I_3= irrigation in whole period of plant growth with determined concentration of wastewater) and wastewater concentration in 6 levels (A= irrigation with pure water (control), C_1=15% wastewaters +85% pure water, C_2= 30% wastewaters +70% pure water, C_3= 45% wastewaters +55% pure water, C_4= 60% wastewaters +40% pure water, P= 100% wastewater). Results indicated that irrigation times had a significant effect on yield and yield components such as pod number, grain number per pod, grain yield and harvest index. Combined effect of irrigation times and wastewater concentration were significant on pod number, grain number per pod, grain yield and harvest index, although this effect was not significant for biological yield. Treatments evaluation showed that increasing wastewater concentration up to 60% increased grain number, grain yield and harvest index, however, at higher concentrations a significant decrease were observed in all traits. It seems that controlled using of wastewater of Iran Mayeh factory (leaven producing factory) with determined concentrations of wastewater at low irrigation times could be an effective practice in increasing of faba bean yield at this region.

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Introduction

In many industrial and agricultural processes, some by-products are produced apart from the useful products. A few years ago, these by-products were considered as wastewater and were often disposed of, causing environmental problems. Recently, it was well recognized that by-products should be considered as useful material, and methods and technologies should be developed to reuse them. In many cases, agriculture can offer a potential solution to these problems by using the material as a substitute for chemical fertilizers and, when the organic matter content is high, as a mean of improving soil texture and growing plant.

Today, using of wastewater is common in many countries (Neyrizi 2002; Al-Rashed and sheriff, 2000) Wastewater and agriculture are two sectors where the economic and environmental benefits of join water management have been demonstrated through case studies around the world. It has been shown that the nutrients embodied in wastewater can increase yields as much or more than a combination of tap water and chemical fertilizer (Lopez *et al*.,2006). The reliable access to wastewater irrigation can improve farm productivity in water-constrained systems (Huibers and van Liner, 2005).

Tavassoli *et al* (2010) to evaluated 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.

Morist (1987) studied the evolution of the mineral nitrogen in the soil and concluded that vinasse causes an increase of microorganism activity in the soil and provided sufficient nitrogen for the plant. the application of safe wastewater with a high nutrient content could be one of the most economical and suitable approaches of solving two problems : waste disposal and increasing soil fertility and growing of plant.

The objective of this study was assessed the effect of deferent irrigation times wastewater of a leaven factory on yield, yield components and harvest index of vicia faba.

Material and method

In the field study the effects of irrigation times and wastewater concentration of Iran Mayeh factory (leaven producing factory) were evaluated on yield and yield components and harvest index of Faba bean were evaluated.

Experiment was arranged in factorial based on randomize complete block design in three replications during 2012 at the field of Iran Mayeh factory located at Garamalek, Tabriz, Iran. The first factor was irrigation times in 3 levels (I_1= one time irrigation with determined concentration of wastewater, I_2= twice irrigations with determined concentration of wastewater, I_3= irrigation in whole period of plant growth with determined concentration of wastewater) and the second factor was wastewater concentration in 6 levels (A= irrigation with pure water (control), C_1=15% wastewaters +85% pure water, C_2= 30% wastewaters +70% pure water, C_3= 45% wastewaters +55% pure water, C_4= 60% wastewaters +40% pure water, P= 100% wastewater).

Field study

The experimental area was ploughed and then plotted in the spring before sowing the seeds.

Experimental plots were sown with regional Garamalek cultivar. the following treatments were established for 1 years in plots of 1.2×1m . Irrigation was started immediately after sowing and plants were irrigated seven times during the growing period. Plants were sown by hand in plots with 20 cm between rows and 5 cm on row spacing. Seeds depth about 3-4 cm and plants in one square meter from central rows at each plot were harvested to determine the grain yield and harvest index.

Data were analyzed by SAS9.0 and figures and graphs were drawn by Excel 2010 software and means compare were carried out using Duncan method.

Results and discussion

Chemical characteristics

The result of wastewater and pure water analysis were shown in table 1. By increasing of wastewater concentration nutrient elements such as potassium, phosphorous, iron, zinc, copper and manganese were increased. Also EC were increased at 60 and 100 ds\m, sodium and chlorine which are the most important elements were increased at salinity at 60 and 100 wastewater percentage (table 1).

Table 1. analysis wastewater at different treatments and pure water as a control treatment.

Treatments	control	15% wastewater concentration	30% wastewater concentration	45% wastewater concentration	60% wastewater concentration	100% wastewater concentration
	A	C_1	C_2	C_3	C_4	P
EC(dS/m)	0.63	1.6	2.76	3.98	5.15	7.94
pH	8.65	7.62	8.14	8.22	8.49	6.26
Na(meq/l)	2.54	8.01	12.59	16.75	23.42	33.88
K(meq/l)	0.14	3.02	6.9	9.61	13.33	21.3
Ca(meq/l)	0.09	1.33	2.44	3.41	4.65	5.53
Mg(meq/l)	0.08	0.30	0.54	0.77	0.98	1.06
Cl(meq/l)	1.75	2.25	4.25	7.5	8.25	12.5
P(mg/l)	0	8.46	20.5	36.9	54.9	144
Fe(mg/l)	0.37	0.70	1.04	1.66	2.24	2.57
Mn(mg/l)	0.48	0.50	0.55	0.59	0.65	0.7
Zn(mg/l)	0.14	0.15	0.14	0.12	0.10	0.09
Cu(mg/l)	0.13	0.18	0.16	0.14	0.13	0.11

A= irrigation with pure water (control), c_1=15% wastewaters +85% pure water, c_2= 30% wastewaters +70% pure water, c_3= 45% wastewaters +55% pure water, c_4= 60% wastewaters +40% pure water, P= 100% wastewater.

Analysis of variance

Pod number

Analysis of variance showed that the effect of irrigation times and wastewater concentration and the interaction of them were significant on pod numbers per square meter . the highest pod number were observed at irrigation in whole period of plant growth with 60% wastewater +40% pure water and irrigation in whole period of plant growth with 30% wastewater +70% pure water treatments (79 and 78.67), respectively. the lowest pod number was achieved from one time irrigation with 15% wastewater +85 % pure water treatments with 44.66 pod per square meter. It seems that by increasing of wastewater concentration, pod number increased significantly. there were no significant differences between irrigation in whole period of plant growth with 30 % wastewater +70 % pure water and irrigation in whole period of plant growth with 45% wastewater +55% pure water treatments. At twice irrigation treatment there was no significant differences between 60% wastewater +40% pure water and 100% wastewater treatments. It was reported that nitrogen and phosphorous which are present in sludge and present in organic matters of wastewater caused to improve soil characters for plant better growth (Saber, 1986).

Grain number

According to the table 2, the effect of irrigation times (first factor) and determined wastewater concentration (secondary factor) had a meaningful on grain number where irrigation in whole period of plant growth with 15% wastewater +85% pure water treatment with having of 114.66 grain per square meter had a highest grain number and at one time irrigation with 15% wastewater +85% pure water with having of 59.60 grain number per square meter had the lowest value. Results showed that there were no significant differences between irrigation in whole period of plant growth with 30% wastewater +70% pure water treatments and irrigation in whole period

of plant growth with 60% wastewater +40% pure water treatments (figure 2). It could be demonstrated that presenting of macro and micro nutrient elements such as iron and molybedon which are the elements of the nitrogen enzyme caused to fixation of nitrogen while iron had a positive effect on chlorophyll which increase number and size of chloroplasts and increase plant photosynthesis and consequence grain number increasing (McBride, 1998).

Table 2. Analysis of variance of data for irrigation treatments and wastewater concentration percentage on evaluated characters of faba bean.

Means of square						df	source
Harvest index	Straw yield	Biological yield	Grain yield	Grain number	Pod number		
2.22	5727.89	3486.68	186.97	148.36	2.58	2	r
57.54*	1212.97	7651.85	807.37*	2046.72*	836.47*	2	Irrigation times (A)
6.16	3080.69	7743.85	378.18	671.79	402.74	5	Wastewater (B)
5.74**	3389.21	6670.40	179.71*	440.17*	412.65*	10	A ×B
7.45	3537.27	6885.652	248.67	585.110	19586.52	34	error
24.5	15.4	19.2	28.3	29.5	27.5		CV(%)

* and ** significant at 5% and 1% levels of probability, respectively.

Grain yield

Analysis of variance of data showed that the effect two experiment factors had significant on grain yield (table 2). According to figure 3, at irrigation in whole period of plant growth with 15% wastewater +85% pure water treatments by means of 69.23 g\m² had the highest grain yield while at one time irrigation with 15% wastewater +85% pure water treatment had the lowest value (31.7 g\m²). There were no statically differences between irrigation in whole period of plant growth with 30% wastewater +70% pure water treatments and twice irrigation with determined wastewater concentration with 60% wastewater +40% pure water treatments. It could be suggested that due to the presenting of needed nutrients in wastewater, including potassium and phosphorus, increased grain yield. Increasing of grain yield at some forage crops due to the using of wastewater has been reported (Feizi *et al*., 2011).

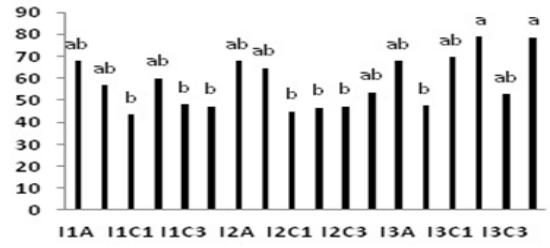

Fig. 1. Means comparison of interaction of different irrigation times with determined wastewater concentration ratio on pod number.

Biological yield

Results of table 2, showed that the effect of the all the treatments had no significant on biological yield, however, irrigation in whole period of plant growth with 60% wastewater +40% pure water treatments by having of 501.66 g\m2 biological yield had the highest traits. Feizi *et al* 2011 illustrated that treatments with wastewater with low micro elements concentration had highest maize biological yield. Cllap *et al.* (1987), studied the effect of municipal filtered wastewater of USA on biological yield of maize and some forage plants, and found that wastewater had fully competitive effect in plant nutrient supply in compare with chemical fertilizers such as Ammonium nitrate.

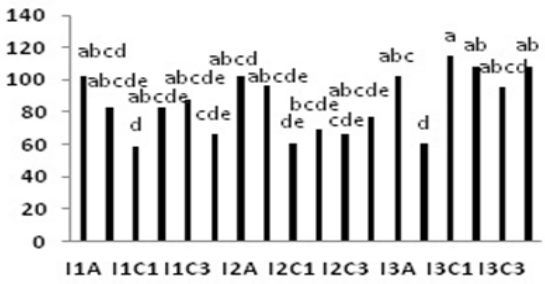

Fig. 2. Means comparison of interaction of irrigation times and wastewater on grain number.

Straw yield

All the treatments had no significant the effect on straw yield of Faba bean (table 2), however, the highest straw yield were observed at twice irrigation

with determined wastewater concentration with 60% wastewater +40% pure water treatments and the lowest straw yield were observed at twice irrigation with determined wastewater concentration with 45% wastewater +55% pure water treatment (427.81 and 317 g\m² respectively) also there were no significant differences between them. Means comparison indicated that wastewater concentration had an increasingly trend with straw yield.

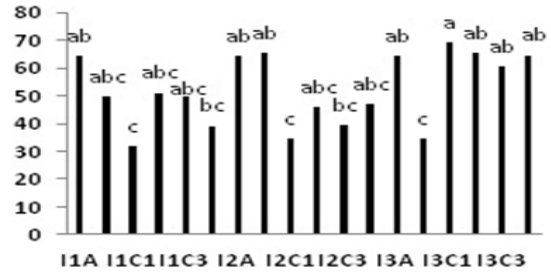

Fig. 3. means comparison of interaction of irrigation times and wastewater on grain yield.

Studied the effect of different ratios of pure water and wastewater had a significant influence on total dry matter yield of forage plants while highest dry forage yield were observed in sorghum(Rezvani Moghadam and Najm Abadi,2008).

Harvest index

Irrigation times and wastewater concentration had a significant the effect on harvest index ($p \leq 0.05$) (table 2). Means comparison indicated that irrigation in whole period of plant growth with 60% wastewater +40% pure water treatments and at one time irrigation with 15% wastewater +85% pure water treatment had the highest and lowest harvest index (17.66 and 9.35 respectively). There were no meaningful differences between irrigation in whole period of plant growth with 45% wastewater +55% pure water treatments and irrigation in whole period of plant growth with 30% wastewater +70% pure water treatments. By increasing of wastewater concentration and irrigation times increased harvest index. This result is agree with Monte and Esousa (1992), which indicated that increasing of wastewater concentration caused to increasing of maize characters such as harvest index, length and diameter of maize ear.

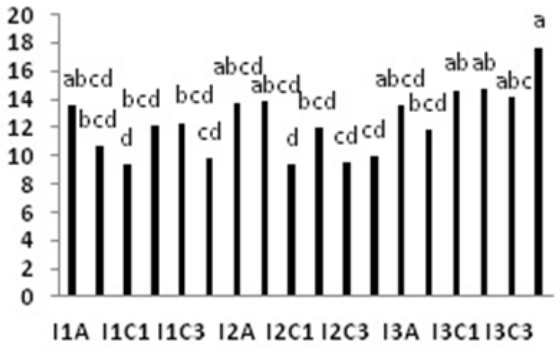

Fig. 4. means comparison of interaction of irrigation times and wastewater on harvest index.

Conclusion

The Results indicated that wastewater by having of macro and micro elements increased yield and yield component and harvest index of faba bean. Irrigation times had meaningful effect on pod number, grain number, grain yield and harvest index. Irrigation in whole plant growth period with determined wastewater concentration had the highest grain number, pod number, grain yield and harvest index. Different wastewater concentration and irrigation times had no meaningful effect on biological yield and straw yield. Interaction effect of irrigation times and wastewater concentration of Interaction effect of irrigation times and wastewater concentration of irrigation in whole plant growth period with15% wastewater +85% pure water treatments had highest pod number and grain yield. Harvest index of irrigation in whole plant growth period with 60% wastewater +40% pure water treatments were more than other treatments. It seems that wastewater application may successfully substitute pure water in vicia faba.

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