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Growth of Black Locust Trees Irrigated With Municipal Effluent in Green Space of South of Tehran

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Abstract: Growth parameters of 15 year-old black locust (*Robinia peseudoacacia* L.) trees were investigated in two areas irrigated 1) by municipal effluent and 2) well water, in south of Tehran, Iran. For this purpose, four sample plots of 30×30 m were randomly chosen in either of both areas. Measurements in sample plots indicated that diameter at breast height (d.b.h.), total height, crown length, crown diameter, basal area and standing volume of black locust trees were significantly greater in municipal effluent area than in well water area ($p<0.01$). Likewise, number, height and standing volume over the d.b.h. classes were greater on the effluent-irrigated site. The results suggest that municipal effluent can be utilized as an important source for providing required water of afforestaions with targets of wood production, green space, recreation and climate health in south of Tehran.

Key words: Black locust, green space, growth, irrigation, municipal effluent, plantation

INTRODUCTION

Water is a most vital source for afforestations especially in the dry zones (Mosadegh, 1999). Iran is a part of arid regions in the world being encountered acute crises owing to the population raise and increased need of water resources (Tabatabaei, 1998). In other hand, municipal effluent can be used to cover the needs of urban and rural areas and parks as well as industrial complexes in order to develop green space and to reduce air pollution (Al-Jamal *et al*., 2000; Singh and Bhati, 2005; Sharma *et al*., 2007). In reality, municipal effluent other than providing water resources for the plantations is an enormous nutrient source (Meli *et al*., 2002; Rattan *et al*., 2005). Apart from this, in plantations utilization of effluent mixed with harmful heavy metals lead to decrease the toxicity, due to a developed rooting system (Karpiscak *et al*., 1996) and as such, the important and fundamental role for the environmental protection can be achieved (Cromer *et al*., 1987; Stewart *et al*., 1990). However, this can not be ignored that the use of effluent for irrigation purposes might damage the ecosystem because of high concentration toxic and heavy metals (Gupta *et al*., 1998; Brar *et al*., 2000; Yadav *et al*., 2002). The accumulation of heavy metals in soil is related to pH, texture and cation exchange capacity of soil (Datta *et al*., 2000). Therefore, decision about the application of effluent should be made based on the views of specialties of water, soil, plant and environment of each location (Naghshinehpour, 1998).

It is noteworthy that thousands liters domestic, industrial and hospital effluents are daily flowing from Tehran metropolitan area and influence the underground water resources. In the same way, 80% of useful water of the citizens in Tehran is also transformed as municipal effluent (Tajrishi, 1998). On the other side, unplanned expansion of Tehran and its air pollution make it unavoidable to increase the green space. In reality, creation of urban green space and green belt around the city can play an effective role in air purification and climate health. Since the lack of water is

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a limiting factor for development of green space, therefore, municipal effluent may be suitable (Torabian and Hashemi, 1999). Till now in the country several researches have been conducted about effect of effluent on soil and agricultural crops, but not on hardwoods. To this reason, the current research plans to determine the effect of irrigation with municipal effluent on the growth of black locust (*Robinia pseudoacacia* L.) tree in an urban green space of south of Tehran.

MATERIALS AND METHODS

The study area is located in Shahr-e Rey, 5 km south of Tehran (35°37' E and 51°23' N, elevation of 1005 a.s.l.). The region possess semi-arid with mild-cold winters conditions and vital growing season (dry season) of seven months (Mid April-Mid November) (Fig. 1). Average annual precipitation is 232 mm and average annual temperature is 13.3°C. The highest precipitation falls in March and the lowest in August. The warmest month occurs in August and the coldest in January.

In this study, two even-aged (15 years) black locust afforestations have been selected. The first stand (40, 000 m^2) was being irrigated by municipal effluent and the second (10, 000 m^2) by well water. The irrigations were carried on 7-10- day durations for 8 months/year (during April-November). The chemical results of each watering followed determining at Laboratory are showed in Table 1 whereas the concentration in most of elements is significantly higher ($p<0.01$) in municipal effluent than in well water.

For the field measurements, four plots of 30×30 m were randomly identified in either of both areas and in each one diameter at breast height (d.b.h.), total height, crown length and crown diameter were measured and basal area computed. Standing volume of each tree was determined by using the form factor (~0.5) and the formula conducted by Zobeyri (1994).

$$V = 0.4 * D^2 \times H$$

Where,

D = Diameter at breast height (d.b.h.),
H = Total height and
V = Standing volume.

In each plot, four soil samples (each with 1 kg) were taken out and then mixed to decrease the number (Habibi Kaseb, 1992). In fact one sample from each plot was obtained to study the texture and nutrient elements (N, P, K, Ca and Mg). In the laboratory, exchangeable Ca and Mg were conducted to titration method with EDTA. K was determined with atomic absorption spectrophotometer, P with Olson and N with Kjeldhal methods. Sampling of effluent and well water

Table 1: Comparison of nutrient elements (mean±SE) between municipal effluent and well water, using the t-test

Source	NH_4-N	NO_3-N	PO_4-P	K	Ca	Mg
	----	----	----	(mg L^{-1})	----	----
Municipal effluent	9.05±0.11[a]	1.63±0.09[a]	12.69±0.167[a]	39.93±0.83[a]	255.22±4.57[a]	109.85 ±1.83[a]
Well water	2.15±0.19[b]	0.24±0.08[b]	5.03±0.001[b]	19.72±0.36[b]	96.77±1.26[b]	35.2±0.790[b]

Different superscripts in column are significantly different ($p<0.01$) (t-test)

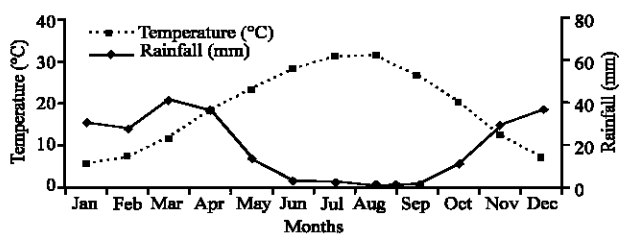

Fig. 1: Embrothermique curve of the study area

was taken out between early June and late November, for a six-month period. In reality it was obtained on three particular days and three times per day (morning, noon and evening). The samples were moved to laboratory for analyzing nutrient elements.

SPSS (ver. 12.5) software was applied to analyze the information acquired during different stages of the research period. Initially, normal distribution of the data was performed using the Shapiro-Wilk's test and then a independent-sample t-test was used to compare the concentration of nutrient elements in well water and municipal effluent as well as to determine the growth parameters of black locust growing in two irrigated areas.

RESULTS

The results of current research conducted by the independent-sample t-test clearly showed that diameter at breast height (d.b.h.), total height, crown length, crown diameter, basal area and standing volume of black locust trees irrigated with municipal effluent were significantly greater ($p<0.1$) than those irrigated with well water (Table 2 and Fig. 2).

It was revealed that the number of thicker black locust trees was more frequent in waste water area. The most frequent trees were found at classes of 12 and 18 cm, respectively grown on sites irrigated with waste water and well water (Fig. 3). The analysis performed by the logarithmic models displayed positive and significant correlations ($p<0.01$) between d.b.h. and total height of black locust trees ($r = 0.74$ and $r = 0.77$, respectively for municipal effluent and well water) (Fig. 4). This implies that in both sites with increased d.b.h. total height gradually increases. However the trees irrigated

Table 2: Significant values of t-test for parameters measured of black locust in two irrigated areas

	Diameter at breast height (cm)	Total height (m)	Crown length (m)	Crown diameter (m)	Basal area of average tree (cm^2)	Standing volume of average tree (m^3)
t-value	8.41	21.92	17.19	16.11	8.49	11.00
p-value	0.00**	0.00**	0.00**	0.001**	0.00**	0.001**

**Significant in 0.01% probability level

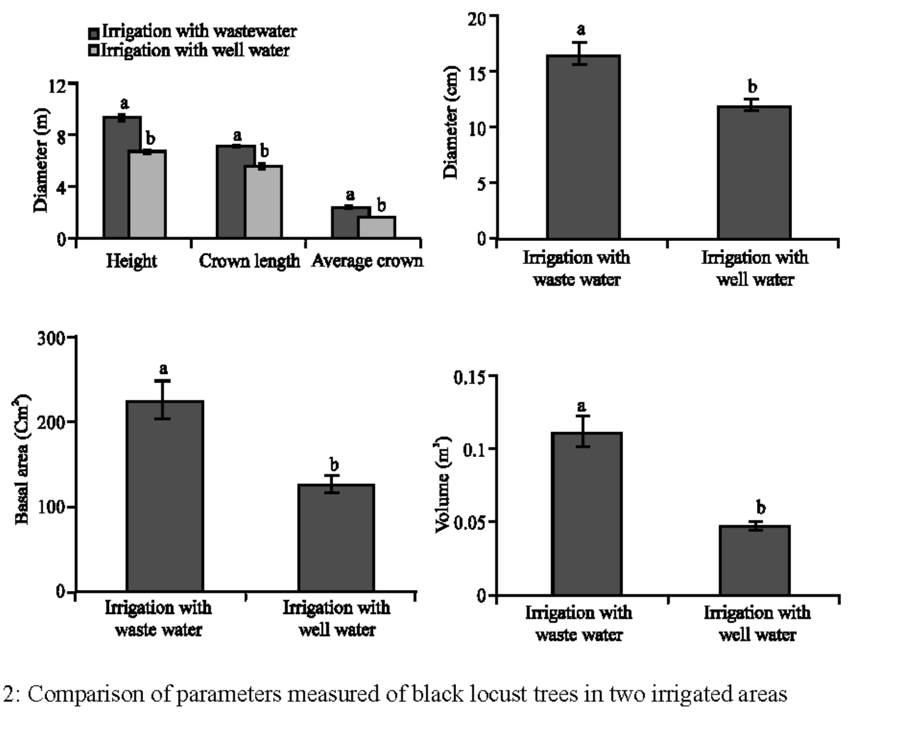

Fig. 2: Comparison of parameters measured of black locust trees in two irrigated areas

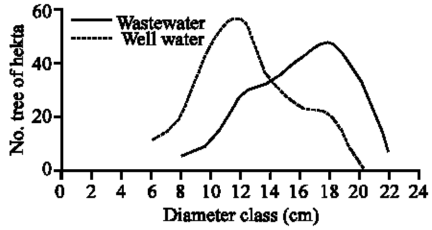

Fig. 3: Distribution of d.b.h. classes for black locust trees in two irrigated sites

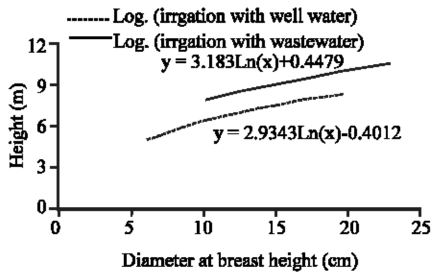

Fig. 4: Correlation between d.b.h. and total height for black locust trees grown at two irrigated sites

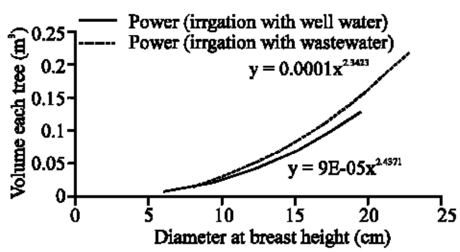

Fig. 5: Correlation between d.b.h. and standing volume for black locust trees grown at two irrigated sites

with municipal effluent show bigger height in all d.b.h. categories. Determining data presented by the exponential models revealed strong, positive and significant correlations ($p<0.01$) between d.b.h. and standing volume of black locust trees in both irrigated areas ($r = 0.96$ and $r = 0.95$, respectively for municipal effluent and well water). In fact, in each site, standing volume raised with increased d.b.h. whereas at higher d.b.h. classes it was greater for the trees grown with municipal effluent (Fig. 5).

DISCUSSION

The present study displayed that all growth parameters measured in black locust trees were statistically greater in effluent-irrigated area than in well-watered area ($p<0.01$). As a whole, the use of municipal effluent in irrigations can be an overflowing resource from the nutrient elements required for plants (Yadav *et al*., 2002; Toze, 2006). In fact, irrigation by effluent causes the enhancement of soil nutrients elements (Safari Sanjabi, 1995; Bagheri, 2000; Meli *et al*., 2002). Generally, high nutrient concentrations in effluent, compared to those in well water, cause the nutrient accumulation in the soil (Stewart and Flinn, 1984; Phillips *et al*., 1986; Stewart *et al*., 1990; Keller *et al*., 2002; Selivanovskaya *et al*., 2001; Emongor and Ramolemana, 2004) and makes easy the access of plants to the high nutrient concentration (macro and micro elements) and increases their growth. Accordingly, in agreement with present findings the results of Stewart and Flinn (1984, on *Pinus eldarica*), Phillips *et al*. (1986, *Pinus eldarica*), Ostos *et al*. (2007, on *Pistacia lentiscus*) show that faster growth occurs in the effluent-irrigated areas. This is mostly due to high nutrient concentration in effluent. It may be also noted that the nutrient contents in the municipal effluent is more than needed by plants whereas in such conditions trees can produce greater biomass (Fitzpatrick *et al*., 1986; Martinez *et al*., 2003; Sing and Bhati, 2005; Guo *et al*., 2006). In reality, irrigation by effluent causes facilitation of foliation, increasesed leaf number, photosynthetic absorption and plant growth (Myers *et al*., 1996). This is while that nutrient content existing in effluents can provide good growth for most of plants. Apart from this, available organic matter in effluent improves soil physical conditions and consequently increases growth and biomass in plants (Singh and Bhati, 2002; Bozkurt and Yarilga, 2003).

Regarding the differences above indicated and the positive effects of effluent on the growth of black locust (*Robinia pseudoacacia*), it can be recommended that the huge municipal effluent in Tehran can be used for accomplishment of plantation projects as well as development of rural and urban green spaces and green belts around the city. It is necessary to clarify that the decision for each location should be made based on accurate management and chemical, physical and microbial characteristics of water, soil and plant, according to international standards.

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