Phytotoxicity of sewagewater and leachate of solid waste on seed germination and seedling growth of *Vicia faba* L. (Faba bean).

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**A B S T R A C T:**

The present study was conducted in greenhouse of Science College during January to April 2017 in order to evaluate the effect of sewagewater and solid waste leachate used for irrigation on some vegetative growth and seed germination of Faba bean (*Vicia faba* L.) plant. The results showed that pH values of sewagewater was near neutrality while leachate was in acid side of neutrality. Electrical conductivity (EC) of leachate pass 8000 µS.cm\(^{-1}\). In most vegetative growth characters of Faba bean plant (Plant height, root dry weight, numbers of flowers, legumes and nodules) the sewagewater treatment record the high values in compared to control treatment. On the other hand, leachate treatments had very harmful effect on plant vegetative growths with lowest value in most variables (except chlorophyll content) with significant differences (P≤0.05) between it, especially at the last months of growth the bean plant of leachate treatment exposed to wilting and dead with zero values recorded for many studied variables (root dry weight and numbers of legumes and nodules). Same results were obtain for seed germination assay irrigated by leachate with lowest germination rate and highest inhibition of germination.

**KEY WORDS:** Phytotoxicity, seed germination, sewagewater, leachate, faba bean.

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**INTRODUCTION:**

Legumes, or pulses, are flowering plants in the Leguminosae family (also known as Fabaceae [Taiz and Zeiger, 2006; Morris, 2003]. Legumes are popular in agriculture for their characteristics in enriching the soil, requiring little fertilizer nitrogen [Caldwell and Grant, 1968]. Faba bean (*Vicia faba* L.) is an important winter pulse crop and green manure legume [Hirich et al., 2014; Hirich et al., 2012; Ismaiel et al., 2014]. The nutritional content make it a good source of protein (more than 25% in dried seed), starch, cellulose, minerals and vitamin C [Duc, 1997].

materials and plant nutrient (N, Ca, Cu, Mn and Zn) are finding agricultural use as a cheap way of disposal, especially in arid and semi-arid areas that originally suffer from shortage of freshwater resources [Taiz and Zeiger, 2006]. Use of domestic wastewater in irrigation of crops and vegetables as a valuable water resource and alternative source to chemical fertilizers [FAO, 1992]. In spite of, these advantage many reports referred to using domestic wastewater can cause several environmental problems such as soil sickness, soil and groundwater contamination and phytotoxicity [Caldwell and Grant, 1968]. Sewage adversely affects many crops such as radish during maturity stage and as a result the production decreases substantially [Mapanda et al., 2005]. Ahmad et al. [2011] observed during their investigation that sewagewater have inhibition effect on chemical soil properties, seed
germination and growth characteristic of different crops. Accumulated solid wastes create a major source of contamination for environment [Shekha, 2013; Shekha et al., 2017]. Management of municipal solid waste (MSW) in non-engineered landfills can’t prevent toxic constituents extracted from leachate to causes potential health hazard to living organisms as a result of surface and groundwater pollution [Turki and Bouzid, 2017; Li et al., 2017]. Leachate is a complex mixture loaded with organic matter, inorganic compounds, heavy metals, and other toxicant generated from physical, chemical, and biological decomposition of MSW [McBean et al., 1995]. Phytotoxicity of landfill leachate have been assessed for several tested plants. [Chaingnon and Hissinger, 2003; Srivastava et al., 2005] attention to use seed germination and root elongation for many plants in eco-toxicity assessment. Vishnoi et al. [2013] mentioned to increasing toxicity of heavy metals in soil solution intake by cultivated plants in soils polluted by leachate. Li et al. [2017] found the inhibitory effects of leachate on both seed germination and seedling growth of some tested plants. Turki and Bouzid [2017] observed better grow of four tested plants irrigated by leachate than those received only water. On the other hand, high doses of leachate causes inhibition growth and reduction of chlorophyll content in Vicia faba was recorded during study conducted by [Gupta and Rajamani, 2015].

The aim of the present study is to evaluate the effects of both sewagewater and leachate on some growth and seed germination characteristics of Vicia faba L. plant.

2. MATERIALS AND METHODS

2.1. Sample collection and analysis

The study was conducted in the green house of Science College, Salahaddin University-Erbil during December to April 2017. The experiment was design as a completely randomized design with three replicates. The soil was packed in plastic pots (7 kg capacity) at a rate of 5 kg. Seeds of Faba bean (4 seeds) were cultivated for each pots. Soil pots were irrigated with treatments (T1: Distilled water as a control, T2: Tap water, T3: Domestic sewagewater, and T4: Leachate of solid waste).

After more than 70 days from started experiment, plant growth was measured. Chlorophyll a content was measured by using (At leaf, V40) in three plant leaves for each replication. The harvested plants were oven dried at 65°C for 48hrs. and immediately dry weight was obtained. Wet digestion with H2SO4 and H2O2 for dried plant material was performed. Potassium and sodium was measured from digested samples by using flame photometer; phosphorus by colorimetric method, while nitrogen determined by kjeldahl procedure [Ryan et al., 2001].

2.2. Seed germination experiment:

Faba bean seeds washed with tap water and presoaked in distilled water for 10hrs. surface sterilization conducted by 10% sodium hypochlorite for ten minutes then washed extensively with sterilized distilled water. Ten seeds with three replication for each treatments were arranged in Petri dish on two filter papers. Ten milliliters of each treatment solutions were added, and incubated at 25°C. for first 5 days germinated seeds were counted and after 15 days PL and RL measurements were recorded [El-Ghamery & Basuoni, 2015].

2.3. Domestic wastewater analysis:

Sewagewater samples were collected from Erbil sewage channel near Sarkars road of Makhmur. While leachate was collected from garbage car in landfill. Sampling and analysis are carried out for each of the different water types used for irrigating the crops during the course of the experiment. Water collected in 2000 ml polythene bottles and transported immediately for laboratory analysis. pH and electrical conductivity (EC) of all water and leachates samples were measured by using pH meter (OAKTON, pH 2100 Series) and EC meter (WTW D 8120) respectively as described by [APHA, 1998].

2.4. Statistical analysis:

One way analysis of variance (ANOVA) was subjected for treatments by using SPSS 22, means were compared using Duncan’s multiple range tests [SAS, 2004]. Statistical significance was defined at P≤0.05.
3. RESULTS AND DISCUSSION

Both pH and EC values of tested water (treatments) used for irrigation pots and germination assay are presented in Table (1). It was observed that pH value tend to an alkaline side of neutrality for control (T1) and tap water (T2) treatments, while it decreased to 6.6 in sewagewater (T3) and become in acid side of neutrality 4.6 for leachate. Osuagwa et al. [2015] reported that petrification of solid waste which contain various human discarded of its food scrapes enriched with fats, proteins and carbohydrates may produce an acid leachate. On the other hand, high value of EC was found in the leachate, it is beyond permissible level (sever potential risk) for crop irrigation [Ayers & Westcot, 1985]. Similar results were found for pH and EC values measured in leachates of Erbil city by [Shekha et al., 2017].

### Table (1). pH and EC (µS.cm⁻¹) values of different water treatments used for irrigation purpose.

| Variables   | Control (T1) | Tap water (T2) | Sewagewater (T3) | Solid waste leachate (T4) |
|-------------|--------------|----------------|------------------|--------------------------|
| pH          | 7.06±0.03a   | 7.53±0.03b    | 6.60±0.37b      | 4.70±0.02b              |
| EC          | 4.80±0.15a   | 3.06±0.15b    | 7.10±0.35b      | 8.30±0.30b              |

Note: Values in each columns with different letters are significantly different at P≤0.05. Values in rows with same letters are not significantly different.

Data in Table (2) shows some vegetative growth of Faba bean plant irrigated by different water treatments. Maximum plant height and root dry weight was recorded in sewagewater treatments (34.6 cm and 12.06 cm respectively), with significant differences at (P≤0.05) to leachate treatment only (Figure 1). This may be related to the nature of sewagewater composition contain most essential nutrients for plant growths which enhanced plant for better growth and fulfill any deficiency of these nutrients in soil [Fathi et al., 2014; Alghobar et al., 2014; Mohammad & Ebead, 2012; Akbari et al., 2012; Khan et al., 2012; Zeid & Abou El-Ghate, 2007]. Generally, in most vegetative growth characteristics for Faba bean plant irrigated with leachate (T4) have lowest growth rate in comparison to other treatments (Figure 2, 3 & 4). This may be attributed to lowest pH and highest EC values of leachate which effect on soil physicochemical properties that reflect on nutrients availability for cultivated plant. In addition to various toxic heavy metals and other organic matter which may inhibited bean growths through effects on metabolic rate and enzymes activities of plant [Adamcová et al., 2016; Farombi et al., 2011; Sang & Li, 2004].

### Table (2). Effect of different types of irrigated water on some vegetative characteristic growth Vicia faba L. (bean) plant (data represented as mean± S.E).

| Variables | Control (T1) | Tap water (T2) | Sewagewater (T3) | Solid waste leachate (T4) |
|-----------|--------------|----------------|------------------|--------------------------|
| Plant height (cm) | 32.16±0.06a | 28.66±0.06b | 34.66±2.40b | 33.68±2.50b |
| Shoot dry weight (gm) | 3.33±0.06a | 6.86±0.06b | 6.33±0.06b | 1.20±0.10b |
| Flower dry weight (gm) | 2.07±0.06a | 2.07±0.06b | 2.07±0.06b | 2.07±0.06b |
| No. of branches | 3.33±0.06a | 3.33±0.06b | 3.33±0.06b | 3.33±0.06b |
| No. of leaves | 23.66±2.06a | 23.66±2.06b | 15.66±2.06b | 15.66±2.06b |
| No. of flowers | 10.33±1.06a | 10.33±1.06b | 10.33±1.06b | 10.33±1.06b |
| Chlorophyll a content | 52.13±1.50a | 42.96±0.95b | 42.96±0.95b | 42.96±0.95b |

Note: Values in each columns with different letters are significantly different at P≤0.05. Values in rows with same letters are not significantly different.

![Figure 1: Shoot and root dry weight (gm.) of Faba bean irrigated by different water treatments.](image1)

![Figure 2: Effect of different water treatments on number of leaves, flowers and leaf area of Faba bean.](image2)
In the late period of growth the bean plant exposed to wilting and dead, that was reflect from results of root dry weight, numbers of legume and nodule, which was zero. That indicated the harmful effect of leachate on soil microorganisms in rhizosphere through several of toxic materials that inhibited and prevent formation of nodules. In contrast highest number nodules and legumes were recorded in bean plant irrigated with sewagewater (Figure 3). This may be related to high nutrients and microorganisms contain in wastewater, which supplied favorable habitat and food availability in rhizosphere zone and enhanced formation of legumes and nodules.

As shown in Table (3), some chemical analysis of bean plant irrigated with different water treatments. It is obvious from results that all analyzed components in bean plant were increased from control treatment to sewagewater treatment with statistically no significant differences at (P≤0.05). As a result of wilting and drying of bean plant irrigated with leachate no plant was available to assay these components. Results reveals that irrigation with sewagewater lead to accumulation of ions, nutrients and other compounds in plant parts of bean plant [Khan et al., 2012].

Table (3): Plant component of Vicia faba L. (data represented as mean± S.E) irrigated by different water treatments.

| Plants components | Treatments | Control (T1) | Tap water (T2) | Sewagewater (T3) | Solid waste leachate (T4) |
|-------------------|------------|--------------|----------------|------------------|-------------------------|
| K mg·gm⁻³         | 62.80±2.400*a | 73.42±7.260*b | 92.51±10.18*b | 00.00± 00.00*b    |
| Na mg·gm⁻³        | 42.08±1.278*a | 50.94±5.854*b | 53.89±6.879*b | 00.00± 00.00*b    |
| Total phosphorus   | 1.152±0.085*a | 3.662±0.717*b | 4.362±2.723*b | 00.00± 00.00*b    |
| Kjeldhal nitrogen  | 1.138±0.170*a | 1.548±0.286*b | 1.71±0.893*b   | 00.00± 00.00*b    |

Note: Values in each columns with different letters are significantly different at P≤0.05. Values in rows with same letters are not significantly different.

In the present study the results of germination assay was arranged in Table (4). Results showed a decrease in germination percentage of bean plant from 52.8% and 8.3% for sewagewater and leachate treatments respectively with respect to control treatment (80.8%). Highest inhibition of germination % observed for last two treatments 37.1 and 81.8% respectively. Turki and Bounzi [2017] confirmed toxic inhibitory effects of raw leachate to seed germination percentage and plant growth, they related that to high nitrogen and salinity content of leachate. High content of toxic organic matter and heavy metals in the leachate may resulted in concealed the action of nutrients that caused inhibition of plant growth [Gupta & Rajamni, 2015; Li et al., 2008]. The plumule and radical elongation was tend to increase in seed irrigated by tap water (T2) compared to control treatment with no significant differences at (P≤0.05) between them, while, it reduced for sewagewater treatment (T3). This may be attributed to phytotoxicity of sewagewater containing various toxic heavy metals suppression growth of seeds. Generally, our results revealed that all seeds treated with leachate showed completely inhibition on plant growth as well as other studied parameters (zero value) (Table 4, Figure 4), with significant differences at (P≤0.05) to other treatments. Li et al. [2017] reported that polluting components of leachate have a greater harm on the germination process. Vishnoi et al. [2013] mentioned that the reduction in shoot and
root length for *Pisum sativum* irrigated with leachate, to adverse effect of heavy metals and their toxicity to plant growth. Toxicity of heavy metals to plants is represented by leaf chlorosis, stunted growth and disturbed of different metabolic pathways [Yadav, 2010].

**Table (4):** Effect of different water treatments on seed germination characteristics of *Vicia faba* L. (data represented as mean± S.E).

| Germinated seed variables | Control (T1) | Tap water (T2) | Sewage water (T3) | Solid waste leachate (T3) |
|---------------------------|-------------|---------------|-------------------|------------------------|
| Germination rate %        | 80.5±15.45  | 77.76±11.69   | 52.83±10.79       | 8.3±3.85               |
| Inhibition of germination %| 6.00±0.00   | 6.82±1.10     | 37.16±1.22        | 51.8±3.20              |
| Phumic elongation velocity| 0.45±0.15   | 0.61±0.03     | 0.30±0.03         | 0.05±0.00              |
| Radical elongation velocity| 0.38±0.04   | 0.43±0.05     | 0.19±0.01         | 0.00±0.00              |
| Length of phumile (mm)    | 6.85±0.34   | 9.12±1.09     | 3.52±0.59         | 0.00±0.00              |
| Length of radical (mm)    | 5.80±0.90   | 6.52±0.91     | 2.84±0.10         | 0.00±0.00              |
| Total length of seedlings (cm)| 12.65±1.28 | 15.99±2.14   | 6.40±1.83         | 0.00±0.00              |
| Dry weight of phumile (g) | 0.07±0.00   | 0.10±0.01     | 0.04±0.00         | 0.00±0.00              |
| Dry weight of radical (g) | 0.00±0.00   | 0.00±0.00     | 0.00±0.00         | 0.00±0.00              |
| Total dry weight of seedling | 0.13±0.04 | 0.16±0.01 | 0.04±0.00 | 0.00±0.00 |
| Shoot/root                | 1.41±0.24   | 1.71±0.14     | 1.90±0.25         | 0.00±0.00              |

**Note:** Values in each columns with different letters are significantly different at P≤0.05. Values in rows with same letters are not significantly different.

**CONCLUSION**

This study mainly was focusing on effects of sewagewater and solid waste leachate on seed germination and plant growth characteristics of faba bean. The finding of the research evidence indicates that sewagewater had a positive influence on increasing of most vegetative growth characters of bean plant counter to leachate with very adverse effects and reduction or even stopping in the vegetative growth (numbers of legumes and nodules). Also, leachate had lowest germination rate and highest inhibition of germination compared with other used irrigated water.

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