Study The Effect of Intermittent and Continuous Ponding Depths by Using Different Heads to Leach Water

Nesrin J. AL-Mansori
Environmental Engineering, Engineering Collage,University of Babylon
Nassrin20052001@yahoo.com

Abstract

As results of using water for irrigated lands in a random manner in a time of shortage main water resources, Experimental work carried out to study the effect of continuous and intermittent ponding depth on the leaching processes. Sandy soil used, sourced from Hilla / Al-Jameeya, at Hilla city. Sieve analysis and hydrometer testing used to identify the properties of the soil. A model used with dimensions of 30, 30 and, 70 cm, with two different heads of water. Shatt-Al-Hilla River samples used in the leaching process. Chemical tests carried out before the leaching process to identify changes in the proprieties in both water and soil.

Leachate collected from two soil columns drained into boxes and tests carried out every 30 minutes. After the leaching process was complete, the soil was re-tested. Chemical tests on soil samples and the collected water applied after leaching for 47.5 cm and 52.5cm heads. From the results‹‹ it can be notice that electrical conductivity for the outlet discharge from soil samples decreased faster with time, then slowing down until the end of leaching process. The same pattern can be seen for all soil properties.

In continuous leaching, a large quantity of water is required over a short leaching period, the inverse true for intermittent leaching. All parameters reduce with time in continuous leaching in comparison to intermittent leaching but when the water level in the soil column compared, it can inferred that increasing the head will reduce all the parameters for soil.

In both continuous and intermittent leaching processes, all parameters tested decreased with time. When comparing continuous leaching with intermittent leaching, it can be noticed that the two heads, increasing the head size results in a faster decrease across all parameters (ph, SO_3, TS S, CL, $CaCO_3$, EC) in both continuous and intermittent leaching processes

Keywords: Water, Soil, Leaching, Head, Depth.

الخلاصة

لاستخدام المياه للارواء بطريقة عشوائية في وقت تندر فيه المياه.تم اجراء العمل المختبري في هذا البحث لدراسة تأثير الغمر المتقطع والغمر المستمر على عمليات التصفية. التربة المستخدمة للدراسة من مدينة الحلة وتحديدا في منطقة الجمعية .تم استخدام التحليل المنخلي لتشخيص خصائص التربة ...مع موديل بأبعاد (30*30*70) سم ...بأستخدام ضاغط ماء بعمقين مختلفين ...نماذج المياه المستخدمة تم اخذها من مياه شط الحلة...وتم اجراء الفحوصات الكيميائية المختلفة للتربة والماء معا قبل اجراء عمليات السقي لنموذج الموديل لمعرفة التغيرات في الخصائص قبل وبعد الارواء.

تم تجميع مياه السقي المبزولة من كلا عمودي التربة في صناديق وتم اجراء الفحص المختبري كل 30 دقيقة ،تم إعادة فحص التربة بعد إتمام عملية الارواء لكلا العمودين بأرتفاع 47.5 سم و 52.5 سم للماء اعلى التربة ..تبين من النتائج بأن التوصيلية الكهربائية للمياه المبزولة من التربة تقل بشكل اسرع مع الوقت مع تشابه النمط في جميع خصائص التربة.

في الانغمار المستمر يحتاج الى كميات مياه اكثر خلال فترة قصيرة على العكس من الانغمار المتقطع..علما ان جميع الخصائص تقل مع الوقت في الغمر المستمر اكثر من الغمر المتقطع..لكن مع مقارنة عمود الماء اعلى التربة نلاحظ بزيادته سيقل جميع خصائص التربة عن ما كانت عليه قبل الانغمار.

مع مقارنة نوعي الغمر أعلاه ...نجد ان زيادة عمود الماء يؤدي الى نقصان اسرع وخصوصا في المحددات التالية(الحامضية ، الكبريتات، المواد الصلبة العالقة.، الكلورايد، كبريتات الكالسيوم، التوصيلية الكهربائية) في كلا النوعين من الانغمار.

الكلمات المفتاحية: الماء، التربة، الانغمار (التصفية) ، العمق ، عمود الماء.

1. Introduction

Salinity in Central and Southern Iraq is so pervasive that its impact on farming systems is a major constraint on agricultural productivity. Saline soils and saline irrigation water reduce the ability of plants to absorb water and thus reduce plant growth and crop yield. Over time, soil salinization may increase to the point where more salt tolerant plants have to be grown or the land will no longer be able to support the growth of vegetation. This affects crop yields and crop choice and ultimately, some farmers may only be able to use their land for the production of halophytic forages. All of this influences food security and farmer's livelihoods. (Franzen *et.al.*, 1994)

Adequate leaching and drainage are necessary to remove the salt left in the root zone after the crop has absorbed irrigation water. Unfortunately, in irrigated areas, the natural drainage capacity of the soil and the groundwater system is usually insufficient to achieve this. As a result, the water table rises. In this situation, engineered drains are necessary to prevent waterlogging and salinization of the crop root zone. In Iraq, this problem can addressed by both improving irrigation practice by using drains to remove water from the soil profile and by leaching salts from the crop root zone. Intermittent irrigation methods involve the intermittent addition of water to the soil thus reducing water loss in the soil. This method used when there is a shortage of leaching water, or if it costs too much. (Franzen *et.al.*, 1994)

The objectives of this study are:

1. To study the impact of ponding depth on the demand water for leaching salts.
2. To study the impact of continuous and intermittent ponding depth on leaching salts for different values of heads.
3. To examine the time required for the leaching process.

2. Leaching Process Work

In agriculture, leaching refers to the loss of water-soluble plant nutrients from the soil, due to rain and irrigation. Soil structure, crop planting, type and application rates of fertilizers and other factors must take into account to avoid excessive nutrient loss. Leaching may also refer to the practice of applying a small amount of excess irrigation where the water has a high salt content, to avoid salts from building up in the soil (salinity control). Where this practiced, drainage must employed to carry away the excess water. (Provin and Pitt, 2001)

(Al Nabulsi, 2001) examined the effect of quality of water, irrigation frequency and crop type on the physical properties of soil. He used two different types of water: pure water and salty water finding that salty water causes a decrease in infiltration and the permeability of soil. (Provin and Pitt, 2001) studied the factors, which increase salts, and the steps needed to treat salty soils including bad drainage, irrigation with highly saline water and the initial salinity of the soil. (Donald, 2001) researched the reclamation of salty soil in the field comparing the field results to a computer program using continuous and intermittent leaching. He found a good level of agreement between field and computer results.

3. Chemical Soil Tests

Several commercial laboratories offer soil chemical testing services that describe the nutrient status of soil and give recommendations about which fertilizers to use. These services however, do not usually include direct measurements of soil structure. That said, as well as providing valuable information about the chemical fertility of the soil, chemical testing can also give some indirect information about the physical condition of the soil. (Wang *et.al.*, 1998)

3.1 pH of Soil

Soil pH is a measure of the acidity or alkalinity of a soil. The term pH applies to solutions, so the analysis must conducted on a soil/water mixture. Soil samples must mixed with water, allowed to equilibrate for at least an hour, before the pH is measured. Primary factor effected on pH is the concentration of salt in the soil (a salt is any molecule that, when placed in water, separates into positively and negatively charged components or ions). Salt concentration may vary according to the season or fertilizer application, and is generally greater immediately following fertilizer application. The result may be a drop in pH of up to 0.5 unit.

When samples collected frequently, or at various times of the year, it can noted that pH values increase and decrease, seemingly at random. This can lead to questions regarding the reliability of soil pH measurements. Such fluctuations however, may be due to changes in soil salt levels and do not usually present a serious problem with reference to the analysis. Some laboratories measure pH in a dilute salt solution to mask salt-induced variations. This method gives lower pH values for which the laboratory should provide interpretation guidelines.

3.2 Electrical Conductivity (Salinity)

Electrical conductivity (EC) is a measure of the ability of a liquid to pass an electric current. EC increases as the salinity of the liquid increases. The unit of measure is dS/m (deciSiemens/metre), EC the electrical conductivity of a saturated soil-water extract. Water removed from newly saturated soil samples by a centrifuge or vacuum pump, the electrical conductivity of the water extract then tested. While EC is the preferred method of estimating soil salinity because it best reflects how salinity will affect plant growth, it is time consuming and not used routinely.

3.3 PH test

EC ratio 1.5 (soil/ solution) is the electrical conductivity of a suspension of one part air-dried soil by weight to five parts water by weight, as for pH (water). This is the most common method because it is easy to do but it is difficult to interpret. EC 1.5 ratio need to convert to EC values in order to do so. Total soluble salts (TSS) were a popular way of expressing soil salinity in the past and are still used by some laboratories, however TSS is not recommended because it cannot be easily related to plant growth (Franzen *et.al.,* 994).

4. Chemical Water Tests

The physic – chemical parameters of the tested water samples described below. (**FAO**.,2003)

4.1 Electrical Conductivity

Conductivity is a measure of current-carrying capacity. As the concentration of dissolved salts increases, conductivity also increases. Many dissolved substances produce aesthetically displeasing colors, taste

4.2 Hardness

Hardness is a measure of the ability of water to cause the precipitation of insoluble calcium and magnesium salts found in higher fatty acids, from soap solutions. The principal hardness-causing cautions are calcium, magnesium bicarbonate, carbonate, chloride and sulphate.

The quantities of calcium in natural water depend on the type of rock. Small concentrations of calcium are beneficial as they reduce corrosion in water pipes. Magnesium hardness, specifically associated with sulphate ions, has laxative effect on persons unaccustomed to it.

4.3 Chloride

Chloride occurs in all types of natural waters. A high concentration of chloride considered an indication of pollution due to high levels of organic waste of animal origin.

5. Experimental Work

The present project has tested the soil and water used in the model seen in Figure. 1, representing the two sections of soil.

5.1 Soil

The soil used in the project taken from Hilla / Al-Jameeya in the middle of Hilla city, at a depth of 80 cm. . Sieve analysis used to determine the class of soil according to

ASTM (1978). It classified as 11.4% fine sand, 12% medium sand, 30% coarse sand and 30.8% fine gravel, soil is sandy silt.

The water content can found by measuring the dried weight. The water content of this soil sample was 22.696. Plastic bags used to keep the soil samples moist and to prevent evaporation from the surface of the soil.

5.1.1 Chemical Tests for Soil Samples before Leaching

Chemical test results for the soils shown in Table 1:

1. Sulphate (SO_3).
2. Chloride (CL).
3. Total Suspended Solids (TSS).
4. Soil of pH.
5. Electrical Conductivity (Ec meter).

Table 1: Chemical tests for soil samples before leaching.

Parameters	Measured values
SO3	9.36733 mg/l
CL	1049.6 mg/l
TSS	4.5%
pH	9.31
EC	3.20 Ms

5.2 Water

A water sample was take from the Shatt Al-Hilla stream, as this represented the most common type of water used in the leaching process.

5.2.1 Chemical Tests of Water before the Leaching Process

Chemical tests of the water, as described in **ASTM** (1978) applied. Table 2 shows the results of these tests, which included:

1. Water of pH.
2. Turbidity (NTU).
3. Total dissolved solid (TDS).
4. Electrical Conductivity (EC meter).
5. Total hardness (TH).
6. Calcium (Ca).
7. Chloride (CL).

Table 2: Chemical tests for water before leaching.

Parameter	Measured values
pH	8.49
Turbidity	8.45 NTU
TDS	0.225 mg/l
EC	4.37 Ms
TH	500 mg/l
Ca	112.2 mg/l
CL	21.9931 L mg/l

5.3 Experimental Design

The models used in this research comprised two glass columns, one for intermittent leaching the other for continuous leaching. Each head of column has dimensions of 30 x 30 x 70 cm and contains 10 cm of gravel, filter papers, 37.5 cm of soil and two collecting boxes, as shown in Figure. 1.

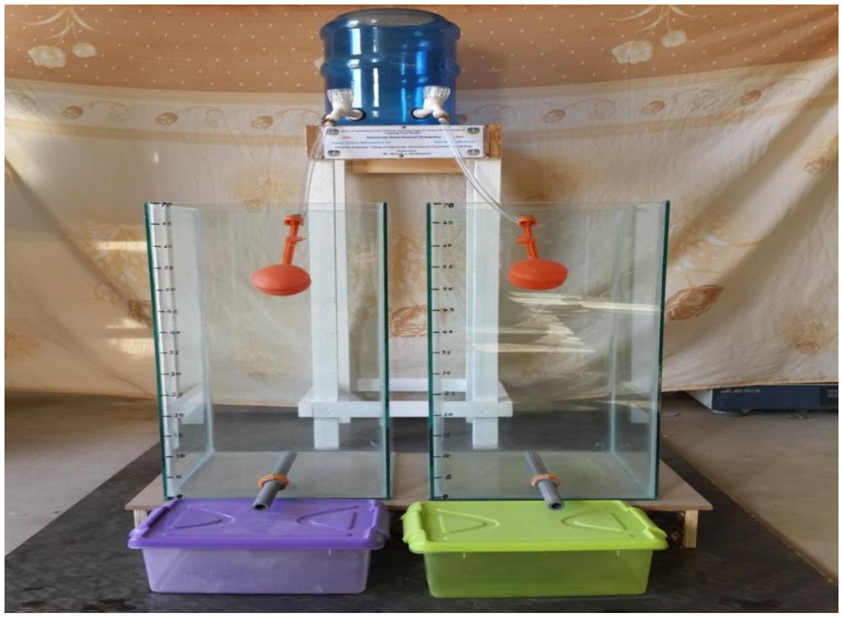

Figure 1: model of soil column

Two plastic tubes to a water tank connect the two-glass soil column. Control valve used to pull water down into the soil column to reach the required head, as shown in Figure.2.

Figure 2: model management

5.4 Experimental Tests

To begin with, each experiment starts with a different head of water, 10 or 15 cm for each column.

Water collected from the two columns drained into the boxes, tests run every 30 minutes. After completing the leaching process, the soil tested with the same tests used before leaching.

6. Results and Discussions

6.1 Continues Leaching Method

Testing begins by drawing water down from the storage tank to the first soil column until it reaches the required head. After 3-4 hours, the water drained from the soil sample into the collecting box. The volume of water and the time taken to collect it, measured after the leaching process is complete.

6.2 Intermittent Leaching Method

Testing begins by drawing water down from the storage tank to the second soil column until it reaches the required head. After 4 hours, the water drained from the soil sample into the collecting box. The supply of water then stopped for two hours after which more water introduced to the soil samples again for another two hours. The volume and time taken to collect the water measured after two hours of leaching. Tables 3 and 4 show the chemical tests applied to the collected water after the leaching process for heads at 47.5 cm and 52.5cm, respectively.

From the tables below, it can see that both leaching processes, continuous and intermittent, produced a decrease in parameters over time. When comparing continuous with intermittent leaching, these reductions are quicker with continuous leaching. In addition, comparing the two heads, increasing the head size leads to a faster reduction across all parameters, in both continuous and intermittent leaching processes.

Table 3: Chemical tests for collected water after the leaching process for h=47.5 cm.

Intermittent leaching					Continue leaching					time
EC	TH	TDS	Turbidity	PH	EC	TH	TDS	Turbidity	PH	
11.31	550	14.4	29.5	9.30	15.16	600	18.4	23.7	9.34	10:00 10:30
7.84	550	10.75	13.8	9.23	8.97	570	11.15	19	9	10:30 11:00
6.77	530	10.00	12.9	9.15	7.17	540	10.8	12.4	8.89	11:00 11:30
5.99		8.85	9.19	9.08	6.63	530	9.5	11.4	8.81	11:30 12:00

Table 4: Chemical tests for collected water after the leaching process for h 52.5 cm.

Intermittent leaching					Continues leaching					time
EC	TH	TDS	Turbidity	PH	EC	TH	TDS	Turbidity	PH	
15.72	590	18.57	31.75	9.43	16.32	630	19.21	24.19	9.45	10:00 10:30
10.39	585	12.31	27.31	9.22	11.94	610	11.94	20.75	9.21	10:30 11:00
8.96	550	10.78	19.83	9.11	10.68	580	11.53	16.33	9.08	11:00 11:30
8.14	547	9.96	18.25	8.95	9.79	575	10.78	14.98	8.97	11:30 12:00

6.3 Soil Tests after the Leaching Process

Chemical testing (TSS, pH, Ec) of the soil carried out after leaching for both soil columns with different heads. From Table 5 it can see that all values for TSS are less than 4% (WHO, 2012). All parameters reduced with time in continuous leaching, more so than in intermittent leaching. When comparing heads, a larger head reduces all parameters for soil across both leaching conditions.

Table 5: Chemical tests for soil after the leaching process.

Head	Intermittent leaching			Continues leaching		
47.5 cm	EC	pH	TSS	EC	pH	TSS
	2.1	9.22	3.5%	2.00	9.08	2.4%
52.5 cm	1.99	9.17	3.3%	1.82	8.91	2.1%

Figures 3, 4, 5 and 6 show the difference in electrical conductivity and total dissolved soils, for both continuous and intermittent leaching processes, for heads of 47.5 cm and 52.5 cm, respectively.

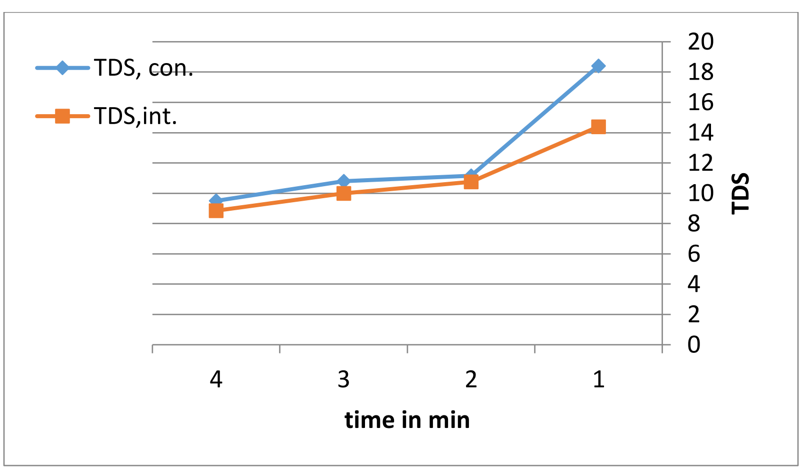

Figure 3: TDS for continuous and intermittent leaching processes for head =47.5 cm

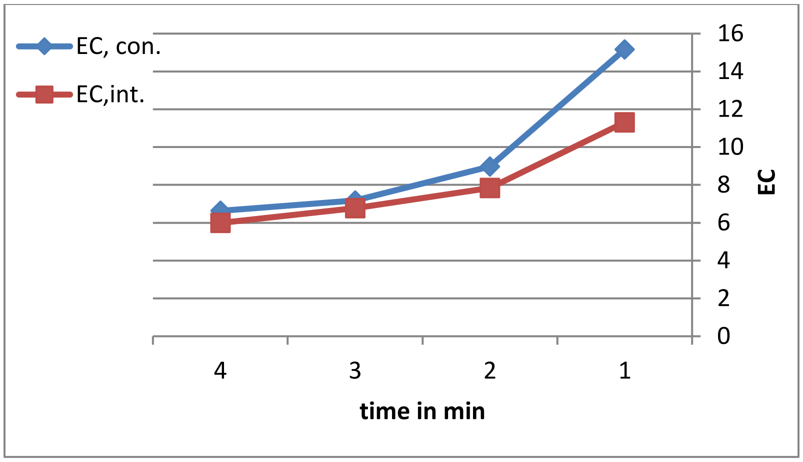

Figure 4: EC for continuous and intermittent leaching processes for head =47.5 cm

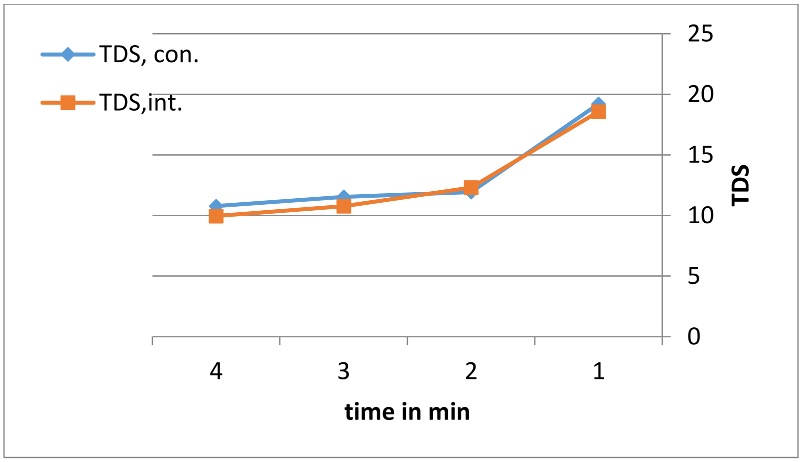

Figure 5: TDS for continuous and intermittent leaching processes for head =52.5 cm

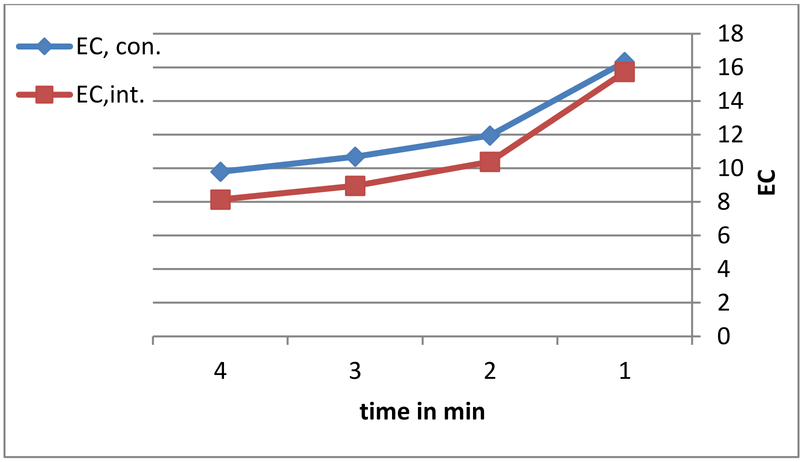

Figure 6: EC for continues and intermittent leaching processes for head =52.5 cm

7. Conclusions

The effect of continuous and intermittent immersion depth on leaching processes with different heads has examined. The results indicate the following:

1. The electrical conductivity for outlet discharges from soil samples decreases faster with time, becoming more gradual until the end of the leaching process.
2. In continuous leaching, a lot of water is required over a short period for leaching, the opposite true for intermittent leaching.
3. All parameters reduced with time in continuous leaching more so than for intermittent leaching. However, when drawing comparisons between sizes of head, a larger head will reduce all parameters across both leaching conditions.
4. In both leaching processes, all parameters decreased with time, this faster with continuous.
5. When leaching salty soil, if time is paramount, it is better to use continuous leaching, but when water is limited, intermittent leaching can be of more -benefit economically.

8. References

Al-Nabulsi A. A., 2001 . "Saline drainage water, irrigation frequency and crop species effect on some physical properties of soil". J. Of Agronomy & Crop Science, 186: (15-20).

ASTM, 1978. Annual book of ASTM standard, part 19. Natural building stones, soil and rock, peats, mosses and humus. American Society for Testing and Material, Philadelphia.

Donalled S., 2001. "Sodic soil reclamation", model and field study. United State Department of Agriculture. Agricultural Research Service, http://www.nal.usda.gov/ttic/teketran/data /000011/71/0000117105.html.

FAO. 2003 . Water quality for agriculture. Irrigation and Drainage. Paper No.29, Rev. 1 FAO. Rome- Italy.

Franzen D . , Fanning C . and Gregoire T . , 1994. "Managing saline soils in NORTH DAKOTA . NORTH DAKOTA State University, Extension Service Bullent (1087), http://www .ext.nodak.edu/extpubs/plantsci/soilfert/sf1087-1.htm.

Provin T. and Pitt J. L. , 2001 . "Managing Saline Soil. Texas Agricultural Extension Service". The Texas A & M University System, http://www.texaserc.tamu.edu.

Wang S., Kitamura Y. and T. Yano. 1998. Reclamation of gypsiferous sodic soils by Leaching soil. Physical conditions and plant growth No.(80):21-32.

World Health Organization, 2012 "Guidelines for Drinking-water Quality", Fourth Edition, ISBN 978 92 4 154815 1.