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# Effect of Bitumen Emulsion Application in Water Movement by Capillarity in Different Textures of soil

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## ABSTRACT

In order to investigate the possibility of reducing the main harmful effects of saline water movement by capillarity in degradation of soils structure and salts accumulation on their surface, an experiment was conducted to evaluate effect of the Bitumen emulsion application on the mechanism movement of different qualities of water by capillary action in three different soils texture (clay, sandy loam and sandy soils), air dried and passed through (2) mm sieve. Half of each soil been mixed thoroughly with Bitumen emulsion of (1%) on dry soil bases and the other half was left without treatment. Soils have been placed into fifty four glass tubes of (100) cm length and (0.8) cm diameter. Three qualities of water (tap water of 1.85 dS $m^{-1}$, mixed water of 6.22 dS $m^{-1}$ and drainage water of 10.48 dS $m^{-1}$) were used. All treatments have been done three times. The height of rising water by the capillarity (cm) at time of measurement (minute) was measured and capillary water velocity (cm $h^{-1}$) was calculated for all treatments (Bitumen, soils and water qualities). All obtained data were statically analyzed by using the SPSS program.

From using the tab, mix and drainage qualities of water, results of the capillary action indicate differences in the water rising values with the different soils and Bitumen treatments. Increasing of salts concentration in the water caused significant decreases in the capillary water rise values throughout the time of measurements of all treatments. The application of Bitumen caused large reduction in cumulative capillary rise and capillary water velocity values at the start and the end of the capillary action time, the reduction percentage values was 70.08% at the beginning and 12.66% at the end of the measurement time. The reduction in upward movement of saline water by capillary action was recorded in all experiment treatments. The results concluded that, coating of Bitumen emulsion to the soil particles and its penetration into aggregates of the soils caused an improvement in the soil structure units and porosity. These newly formed units of soil structures were not affected by the salt level present in the rising water by capillarity. The application of Bitumen caused increasing in the macro pore spaces (drainage pores) and reduction in the micro pore spaces (capillary pores) of the soils, which, consequently, resulted in a decline in rising movement velocity of saline water by capillarity in all soils.

**Keywords**: Bitumen Emulsion Application, Water Quality, Capillary Water Rise, Capillary Water Velocity, Soil Texture.

## INTRODUCTION

Water capillary action is the movement of water along microscopic channels, as a result of two forces: the adhesion and absorption of water by the walls of the channels; and cohesion of water molecules to each other [1]. Free water at the water table is attracted by adhesion to the hydrophilic surface of soil mineral particles, causing the water to spread out in a thin film with a contact angle of essentially zero. Pressure is always lower on the convex side of a curved interface; therefore, the water rise in the pore until the difference in pressure is just balanced by the weight of the water pushed above the water table [2].

It occurs because of inter-molecular attractive forces between the liquid and solid surrounding surfaces; which is highly affected by texture of the soil. If the diameter of the tube is sufficiently small, then the combination of surface tension (which is caused by cohesion within the liquid) and adhesive force between the liquid and the container acts to lift the liquid [3].

Using of oil mulch (Bituminous) by [4] as an evaporation inhibitor on a sandy soil decreased the evaporation rate by 45% under field condition. Consequently, the reduction in evaporation of water from soil surface will limit the movement and elevation of water table rising by capillary action to the soil surface. On their previous studies, [5] indicated that surface mulching with Bitumen emulsion was considered as one of the applied techniques that can provide adequate conditions for sandy soil plantation. It protects the soil against wind and water erosion, reduces evaporation, increases the preserved moisture below the mulch layer and modifies soil structure and temperature [6].

An experiment on the effect of two anionic Polyacrylamide molecular weights, using deionized water on the stability of aggregates of four soils varying in clay content indicated a significant interaction among all the treatments [7]. Moreover, [8] found that all soil conditioners irrespective of their concentrations, which have been applied to the sandy loam soil, significantly increased the number of micro-pores and the respiration activity which were accompanied by a decrease in the number of macro-pores, as well as a decrease in the cone index and bulk density and increase the specific surface area of the soil and the moisture holding capacity of the surface layer of the soil.

Salinity means the presence of soluble salts in or on soils, or in water, therefore, for salinity management purposes, it is necessary to assess the suitability of water quality and soil structure or texture for irrigation [5]. The main concern with increasing salinity of irrigation water or of water table is decreased crop yields and soil degradation as a result of excess salts being present in water and soils or salts rising with water by capillarity in soil [3] and [9] . However, water moves with salts when matric potential is zero at wetting front; then water can move from high to low potential; similar with capillary rise [10].

A little is known about the interaction effects of Bitumen emulsion, soil texture and water quality on capillary water rise and capillary water velocity. Knowledge of how Bitumen affects water capillary action in soils can be very important in reducing the accumulation of salts rising with the capillary water on the soil surface, especially when the water table above the critical level. Therefore, an experiment was carried out on the application of Bitumen emulsion for different soil textures in order to investigate in the mechanisms of capillary rise and capillary velocity of different water salinities under different soil textures.

**Materials and Methods**

A research was conducted at the Agriculture College, University of Basrah, Iraq, using three textures of soil (clay, sandy loam and sandy soils). The clay soil was collected from the surface layer of (0-10) cm depth of Abu Al-Kassib region, south of Basrah, which was classified as Typic Torrifuvent [11]. The sandy loam and sandy soils were collected from Al-Birgesia Agricultural Research Station of the Ministry of Agricultural, south of Basrah, Iraq. The two soils were classified as Typic Torripsamments. Each soil was air dried, mixed and passed through (2) mm sieve (in order to obtain a uniform soil particles size distribution)

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before being placed into fifty four glass tubes of (100) cm length and (0.8) cm diameter.

Glass wool was placed and hold in the bottom end of each tube before filling them with air dry soil up to a few cms. from the top end. Half part of the required quantity of each soil was mixed thoroughly and individually with 1% (on dry soil bases) prepared Bitumen emulsion 50% active material as a hydrophobic conditioner in order to obtain soil treated with and without Bitumen emulsion.

Lower end of each soil tube was immersed in water (to obtain soil bottom end just by touching water surface) by using three qualities of water (tap water of 1.85 dS $m^{-1}$, mixed water of 6.22 dS $m^{-1}$ and drainage water of 10.48 dS $m^{-1}$) in order to measure the height of water (cm) rising by the capillary action at time of measurement (minute). The obtaining data can be used to calculate water velocity by capillarity (cm $h^{-1}$) for each water quality, soil texture and Bitumen treatments.

Appropriate primary physical and chemical properties of three soils and of water qualities were determined (Table1) according to the procedures described by [12] and [13]. The data clearly showed that there are differences in properties between soil textures and between water qualities.

The Bitumen emulsion has no-fixed chemical structure, and the specific gravity values is 1.01 g $cm^{-3}$, viscosity is 2.40 centipoise, pH =7.8 and EC=0.3 dS $m^{-1}$.

Table (1): The primary properties of physical and chemical analysis of soil textures and water qualities.

| Physical-Chemical Analysis | Measurement Units | Soil texture | | |
|---|---|---|---|---|
| | | Clay | Sandy Loam | Sand |
| pH | | 7.9 | 7.7 | 7.5 |
| EC | dS $m^{-1}$ | 4.14 | 3.11 | 2.43 |
| $Co_3^{-2}$ | ppm | 0.0 | 0.0 | 0.0 |
| $HCO_3^{-1}$ | ppm | 16.50 | 10.50 | 8.30 |
| $Cl^{-1}$ | ppm | 60.30 | 43.50 | 22.80 |
| $Na^{+1}$ | ppm | 37.00 | 19.91 | 12.54 |
| Clay | gm $Kg^{-1}$ | 475.43 | 84.34 | 37.10 |
| Silt | | 321.25 | 217.17 | 50.25 |
| Sand | | 203.32 | 693.49 | 912.65 |
| Field capacity | gm $gm^{-1}$ | 0.3060 | 0.2210 | 0.1830 |
| $\rho_s$ | Mg $m^{-1}$ | 2.65 | 2.68 | 2.69 |
| $\rho_b$ | Mg $m^{-1}$ | 1.32 | 1.44 | 1.56 |
| Porosity | | 0.5019 | 0.4627 | 0.4201 |
| MWD | mm | 0.82 | 0.18 | Nil |
| Water analysis | Units | Tap water | Mixed water | Drainage water |
| pH | | 7.0 | 7.5 | 8.0 |
| EC | dS $m^{-1}$ | 1.85 | 6.22 | 10.48 |
| $Cl^{-1}$ | ppm | 0.0065 | 0.0425 | 0.0800 |
| $Na^{+1}$ | ppm | 60 | 370 | 700 |

**Results and discussion**

Statistically at each Bitumen treatment, the differences in capillary rise values between the treatments of soil textures, water qualities, time of measurements and the possible interactions within the treatments were highly significant at P=0.001 (Table 2). There is an increase in the cumulative capillary rise values with time of measurement for all water qualities in each soil and Bitumen treatments (Figure 1 and 2). All graphs showed highest, intermediate and lowest trend for tab, mixed and drainage water quality treatments, respectively. In both treatments with and without Bitumen, increases of salts concentration in the water caused decreases in the capillary action of water rising in the soils throughout the time of measurements. This can be attributed to the fact that the solute potential of the water declines with the increase of salts concentration, the negative part of the salt holding the positive molecular part of water which causes a reduction in the solute potential of the water [14]; [15].

Table (2): Variance analysis (F values) of capillary water rise data for dependent variables. All values are significant at P=0.001.

| Source | Without Bitumen | With Bitumen |
|---|---|---|
| Soil texture (A) | 208653.94 ** | 56189.25 ** |
| water quality (B) | 6933.40 ** | 7201.28 ** |
| Time(C) | 29402.56 ** | 103977.44 ** |
| A*B | 556.60 ** | 98.24 ** |
| A*C | 3149.81 ** | 2814.86 ** |
| B*C | 63.28 ** | 144.81 ** |
| A*b*C | 26.35 ** | 16.10 ** |
| R. squared | 1.00 | 1.00 |

At the untreated soil treatments with Bitumen, the sandy loam soil, gave highest values of capillary rise at the start and the end of the experiment (Figure 1). The mean values of capillary rise for the clay, sandy loam and sandy soils are 2.36, 19.30 and 17.54 cm. at the start (after 10 minutes) and 40.19, 73.87 and 35.24 cm. at the end (after 90 hours), respectively. These results are coincided with those obtained for the water quality treatments at each soil texture.

Treating the soils with Bitumen emulsion caused clear changes in the capillary action of each soil texture (Figure 2). The capillary rise values in the clay soil increased at the start and decreased at the end time of measurement. In the sandy loam soil, the values decease at both starting and ending time of measurement, while in the sandy soil, the values decrease at the start and increase at the end time of measurement. These differences in results can be attributed to the development in soil structure units and the changes in pore sizes distribution of each soil which occurred due to the differences in response of each soil texture to the effect of Bitumen emulsion in binding of soil particles together [16]; [17] .[8] revealed that all soil conditioners irrespective of their concentrations significantly increased the number of micro-pores in the sandy loam soil which were accompanied by a decrease in the number of macro-pores.

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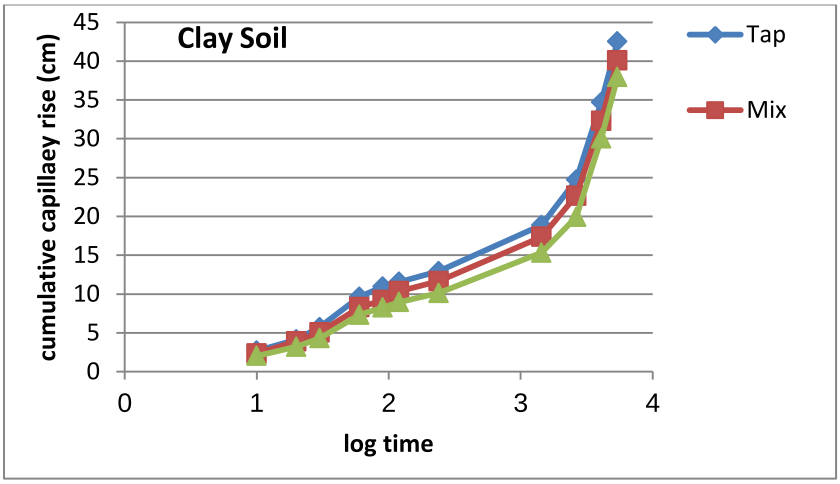


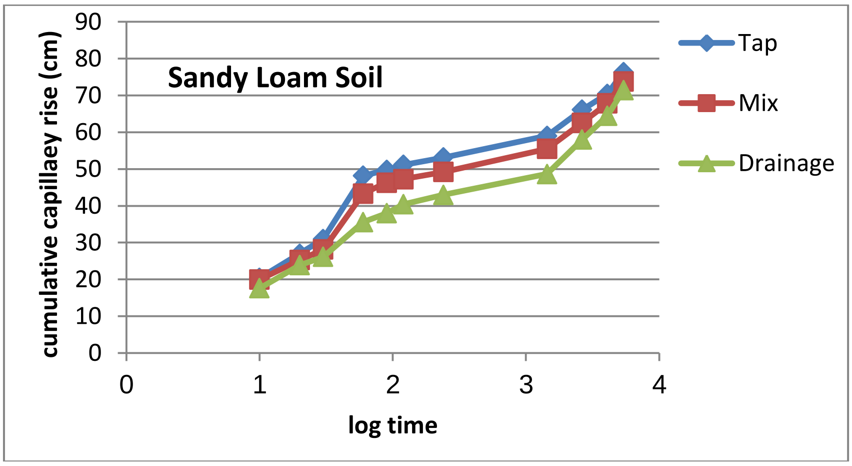


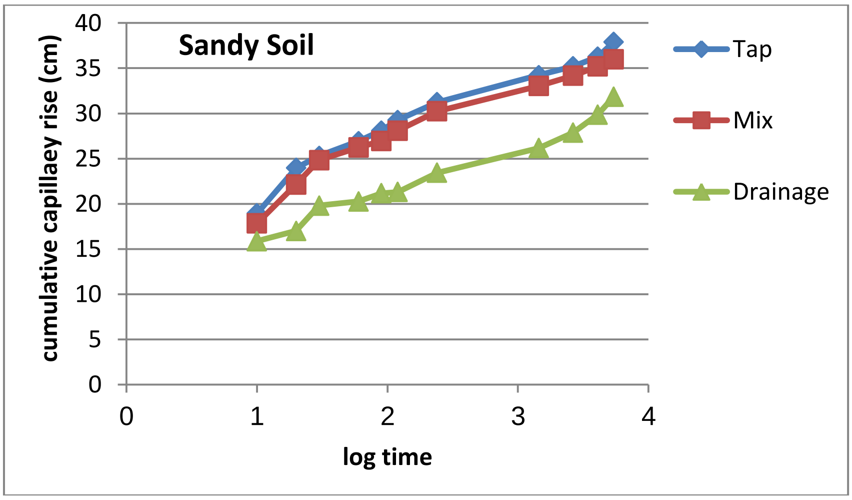


Figure (1): The relationship between the cumulative capillary rise of water (cm) and time of measurement (log time) in minute for clay, sandy loam and sandy soils without Bitumen. RLSD at (P> 0.01) = 0.286.

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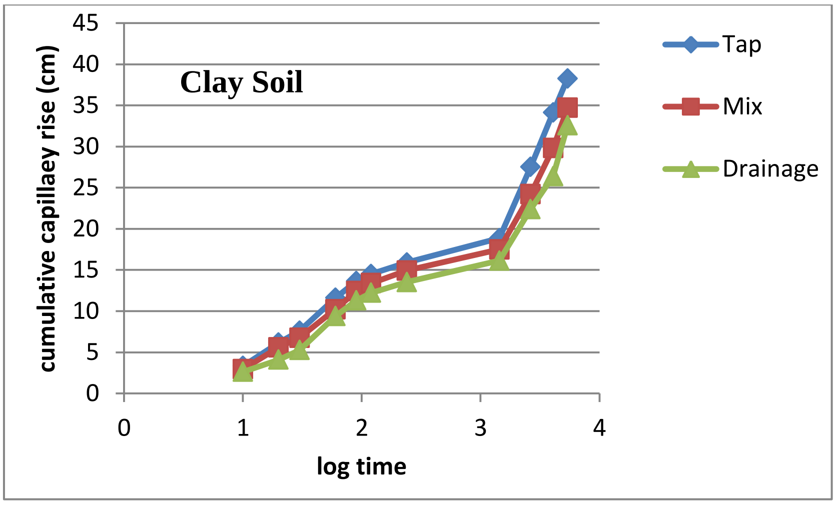


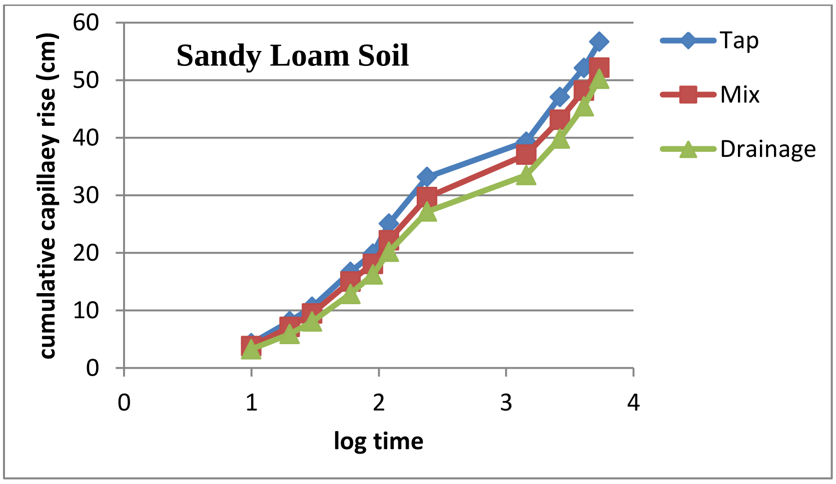


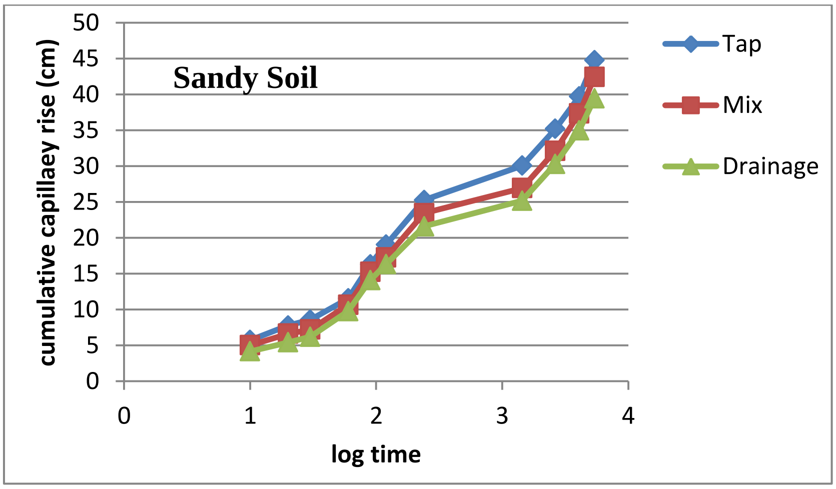


Figure (2): The relationship between the cumulative capillary rise of water (cm) and time of measurement (log time) in minute for clay, sandy loam and sandy soils with Bitumen. RLSD at (P> 0.01) = 0.178.

However significant differences were found in RLSD analysis at P=0.01 in the total mean of data of rising water by capillary action within the treatments of soil textures (Figure 3 & 4) and water qualities (Figure 5 & 6) of the treatments without and with the application of Bitumen emulsion, respectively. The clay soil and the drainage water revealed the lowest data; and the sandy loam soil and the tap water gave the highest values; while the sandy soil and the mix water have the intermediate data within the experiment treatments. High concentrations of sodium in irrigation water can result in the degradation of soil structure; this will reduce water infiltration and penetration into the soil surface and down the soil profile; as well as slow down the capillary rise of water to the soil surface [2]; [18]. The main harmful effect of saline water on degradation of soil structure could be reduced to the minimum by adding the Bitumen emulsion to the soils.

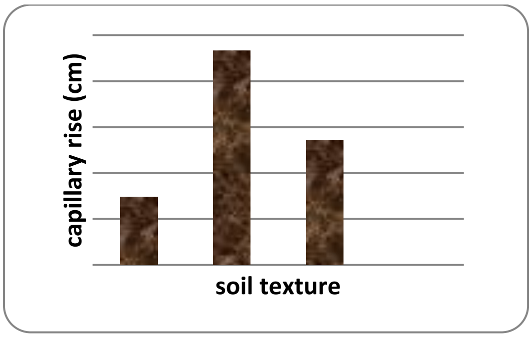


Figure (3): Effect of soil texture on water capillary rise values (cm) of treatments without Bitumen. RLSD at (P > 0.01) = 0.599.

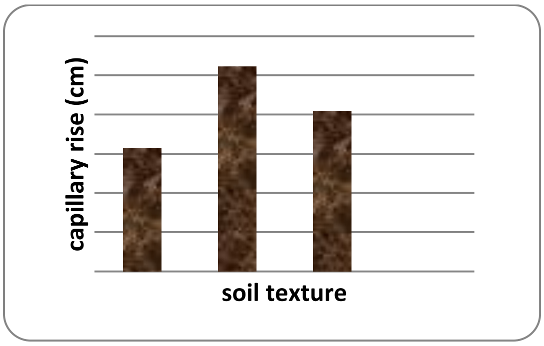


Figure (4): Effect of soil texture on water capillary rise values (cm) of treatments with Bitumen. RLSD at (P > 0.01) = 0.309.

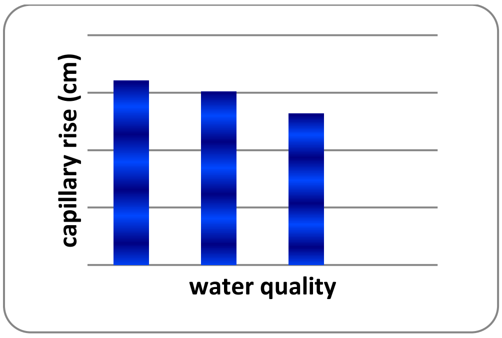


Figure (5): Effect of water quality on water capillary rise values (cm) of treatments without Bitumen. RLSD at (P > 0.01) = 0.243.

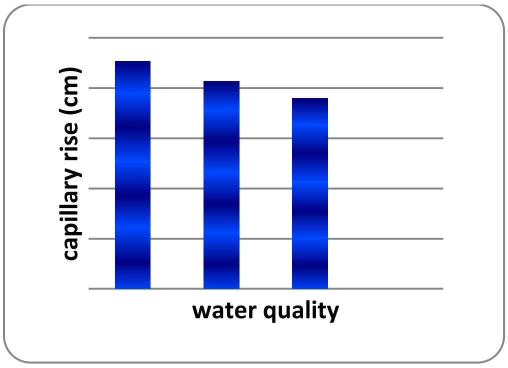


Figure (6): Effect of water quality on water capillary rise values (cm) of treatments with Bitumen. RLSD at (P > 0.01) = 0.309.

The mean values for all capillary rise data despite of the effect of treatments, indicated an increase in the trend of cumulative capillary rise values throughout the time of measurements in both treatments without and with Bitumen application (Figure 7 and 8). The discrepancies in water capillary rise values were more or less similar in both graphs with and without Bitumen. The application of Bitumen cause large reduction in values at the start and end of the capillary rise. The start and end values for the treatments without Bitumen were 13.07 and 49.77cm and for the treatments with Bitumen were 3.91 and 43.47cm, respectively. In general, the reduction percentage values were 70.08% at the start and 12.66% at the end of the measurements. Using the Bitumen emulsion as an evaporation inhibitor on a sandy soil resulted in a decrease in the evaporation rate by 40% under field conditions, which is related to the improvement of soil structure stability (increase of micro-pores and decrease of macro-pores of soil) and soil water retention. [4].

T-test analysis resulted in a significant differences in capillary rise values between the treatments without and with Bitumen, (i.e. T-value =14.54). This is related to the direct effect of Bitumen emulsion in improving soil aggregate stability and sizes of which have consequently a dramatically effect on the continuity and distribution of pore sizes in the soils [4;16].

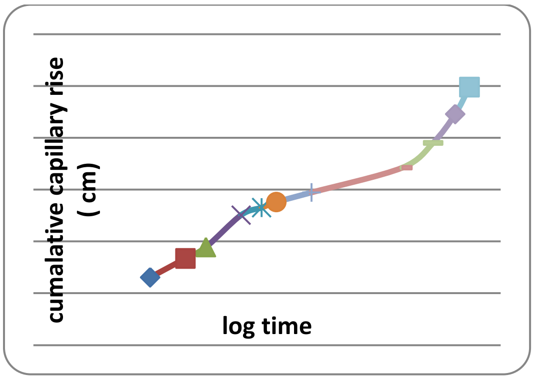


Figure (7): The relationship between time of measurement (log time) in minute and cumulative capillary rise of water values (cm) of treatments without Bitumen. RLSD at (P > 0.01) = 0.165.

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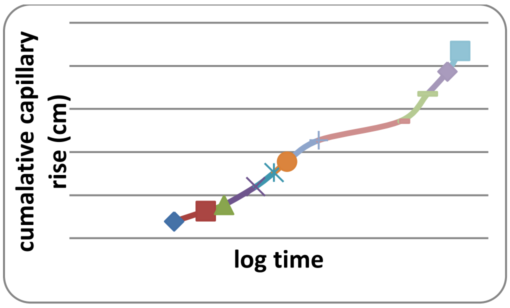


Figure (8): The relationship between time of measurement (log time) in minute and cumulative water capillary rise values (cm) of treatments with Bitumen. RLSD at (P > 0.01) = 0.165.

The analysis of variance (F values), of the data for the treatments without Bitumen, indicated significant differences in water velocity values between treatments of soil textures, water qualities and times of measurement; the bidirectional interactions within soil textures and times of measurement and also within water qualities and times of measurement were significant only, (Table 3). While the data for the treatments with Bitumen indicated significant differences in values between the treatments of soil textures and between times of measurement only; all the possible interactions within the treatments were not significant.

Table (3): Variance analysis (F values) of water velocity data for dependent variables. * Values are significant at P = 0.05, ** Values are significant at P=0.001 and ns. are not significant values.

| Source | Without Bitumen | With Bitumen |
|---|---|---|
| Soil texture (A) | 357.08 ** | 4.28 ** |
| Water quality (B) | 4.55 * | 2.39 $^{ns}$ |
| Time (C) | 295.13 ** | 21.57 * * |
| A*B | 0.88 $^{ns}$ | 0.97 $^{ns}$ |
| A*C | 50.64 ** | 1.46 $^{ns}$ |
| B*C | 2.00 ** | 1.21 $^{ns}$ |
| A*B*C | 1.27 $^{ns}$ | 0.98 $^{ns}$ |
| R. squared | 0.960 | 0.622 |

The calculated data for the water velocity in (cm $h^{-1}$) for all the experiment treatments revealed differences in values with almost identical trends, it seems that, the untreated soils gave higher values than those soils treated with Bitumen (Figure 9 and 10). There are decreases in values with increasing time until reach nearly constant values at end time of measurement. [11;19] and [9] found that the average upward water velocity and water infiltration rate were high at the beginning, but on the long run it gradually decreases until they reached an approximately constant rates.

Examination the velocity results in Figures (9) and (10) of water quality treatments for each soil texture indicated that, in general, there is an increase in variations between trends with the decrease of time of measurement. On the other hand, natural soils untreated with Bitumen showed less variations in trends of water velocities between the water qualities treatments as compare with Bitumen-treated treatments. This can be attributed to the differences in response of soil textures to the effect of Bitumen emulsion in binding soil particles together to introduce soil aggregates of variant sizes with each soil texture [16;4].

The developed aggregate sizes may produce significant differences in water velocity movement between soils. In the clay soil, the Bitumen amendment increases the macro-pores sizes and decreases the micro-pores sizes, whereas, in the sandy loam and sandy soils the vice versa occurs, i.e. the amendment decreases the macro-pores and increases the micro-pores, these phenomena could alter the hysteresis of each soil in different ways, which can directly affect the upward and downward movements of water in the soils [20;21].

In both Bitumen treatments, large differences in water velocities were recorded between the start and end values of each soil texture and water quality treatments. The water velocity values at the start were greater than those of the end in all experiment treatments, and the discrepancies in values between soil textures were much higher than those between water quality treatments. The speculations of these results revealed that the pores size distribution of soil are the main part of soil which can be affected by soil conditioners or soil management which are considered as a limiting factor of how water moves through the soil [22;23]. At the bottom of the soil columns (near the water source) water rises more rapidly in the sandy soil where the capillary conductivity of the larger pores is greater than the clay soil which has smaller pores and attracts water more strongly than the large sandy soil pores, but transmits it more slowly. [24] indicated the rate of water movement and the amount of water retention are related to the pores and particles sizes distribution in the soils.

However, the application of Bitumen to the soils caused a clear decline in the starting water velocity values of sandy loam and sandy soils for all water quality treatments, whereas, the clay soil showed incline in starting velocity values. The values at the end of the measurements of the Bitumen treatments indicated a decrease in values of clay and sandy loam soils and an increase in the values of sandy soils at all water quality treatments as compared with the treatments without Bitumen. Factors which influence mechanism of water movement through the soil include soil texture, structure, organic matter, bulk density, and any condition that affects sizes and shapes of pores in the soil, like tillage, compaction, residue, decayed root channels, worm holes and soil conditioners [24;25].

The results in Figures (9 and 10) also declare that the tap and drainage water qualities have the highest and lowest velocities of water in both treatments without and with Bitumen, respectively, while, the mixed water quality has the intermediate values. In general, the total mean values of water velocities for all treatments at the start and the end of measurements were 78.41 and 0.55 cm $h^{-1}$ for treatments without Bitumen and 23.48 and 0.48 cm.$h^{1}$ for treatments with Bitumen, respectively.

The results concluded that the application of Bitumen emulsion caused a reduction in the velocity of water qualities in all soil texture treatments. These finding of results revealed that the penetration of Bitumen into the soil and its improvement to the soil structure were not affected by the salt level present in the water qualities.

These results was opposed to those found by [26; 7] on the distributions of Polyacrylamide (PAM) in the soil profile, where, their results showed that the penetration of PAM into the soil profile was affected by salts concentration of irrigation water, soil texture, initial soil water content, water application method, and other factors.

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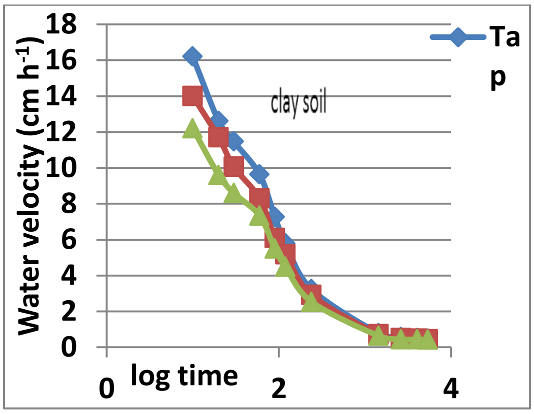
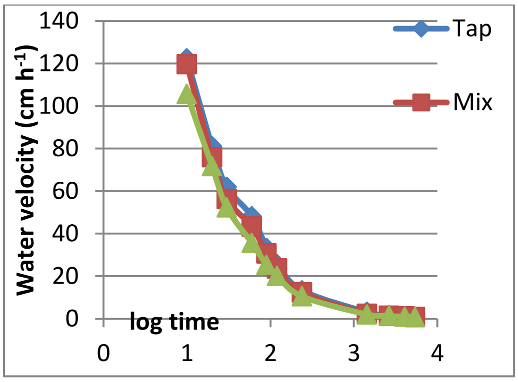



Sandy Loam Soil




Sandy Soil

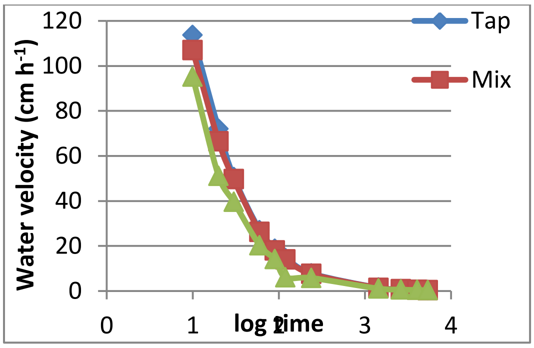
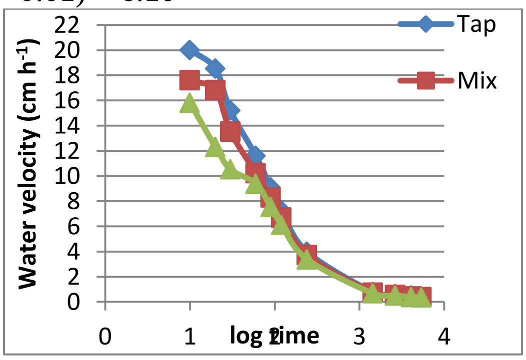



Figure (9): The relationship between velocity of water (cm $h^{-1}$) and time of measurement (log time) in minute for clay, sandy loam and sandy soils without Bitumen. RLSD at (P > 0.01) = 6.10

Clay Soil



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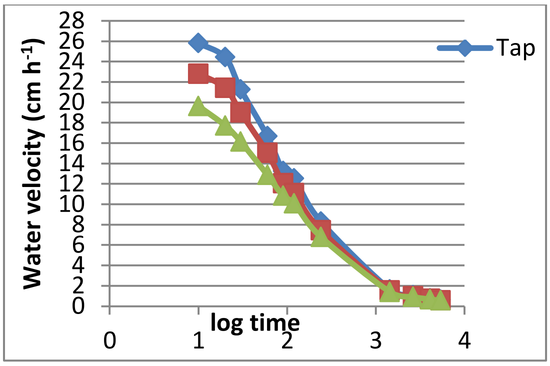
**Sandy Loam Soil**




**Sandy Soil**

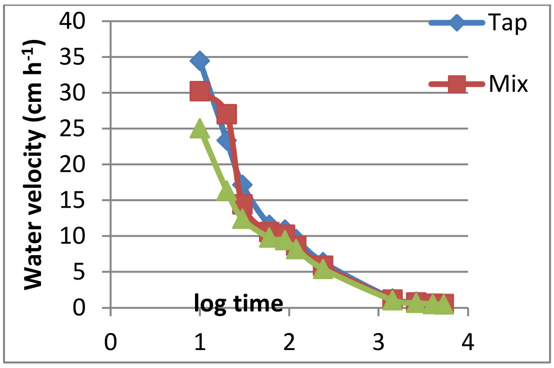



Figure (10): The relationship between velocity of water (cm $h^{-1}$) and time of measurement (log time) in minute for clay, sandy loam and sandy soils with Bitumen. RLSD at (P > 0.01) = ns.

Regardless the individual effect of each experiment treatment, the variations in total mean values of water velocity between soil textures (Figure 11 & 12) were much higher than those between water qualities (Figure 13 & 14) for the treatments without and with application of Bitumen, respectively. The total mean values of treatments without Bitumen application have significant differences in RLSD = 3.50 at P=0.05 between soil textures (Figure 11). The differences in total mean values of water velocity between water qualities treatments were not significant (Figure 13). The highest values in the experiment treatments without Bitumen were recorded in the sandy loam soil and tap water treatment; the lowest values were recorded in the clay soil and drainage water treatment; while the sandy soil and mix water treatment introduced intermediate values. Pore size is one of the most fundamental soil properties affecting water movement through the soils; the rate at which water moves through soil is primarily a function of soil texture and soil structure; where larger soil pores, such as in sand, conduct water more rapidly than smaller pores, such as in clay. However, at long term, water eventually rises higher in the clay soil where the pores are smaller and closer together.

The addition of Bitumen to the soils changed the structure behavior of each soil texture toward the movement of water qualities by capillary action (Figure 12 and 14). Despite of the individual effect of each treatment, the velocity of water was decreased in all soil textures and water quality treatments by the application of Bitumen emulsion to the soil. However, an exception was observed in the clay soil which showed a little increase in values.

The water velocity values indicated significant differences between soil textures (RLSD=5.43 at P=0.05) and non-significant differences between water quality treatments. The greatest decrease occurred in the sandy loam soil and the tap water

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due to the addition of Bitumen emulsion compared with those treatments without Bitumen. This may indicate that the direct effect of Bitumen emulsion in improving soil structure and pores size distribution caused a reduction in upward movement of saline water by capillary action, which resulted in small variations in water velocity values between water quality treatments. [27] found that the presence of coarse stable aggregates which formed by the Bitumen in the soil breaks the capillary continuity of the soil and hinders water movement from deep layers to the site of evaporation.

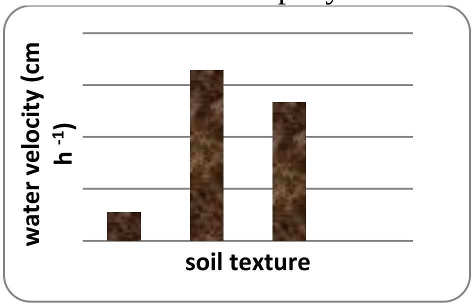


Figure (11): Effect of soil texture on velocity of water values (cm $h^{-1}$) of treatments without Bitumen. RLSD at (P > 0.01) = 2.02.

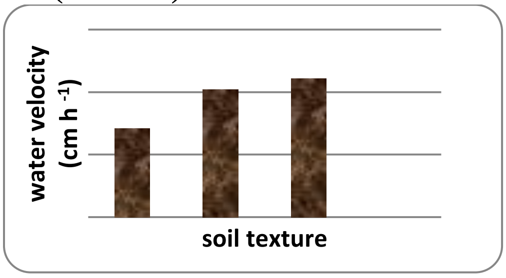


Figure (12): Effect of soil texture on velocity of water values (cm $h^{-1}$) of treatments with Bitumen. RLSD at (P > 0.01) = 2.5.

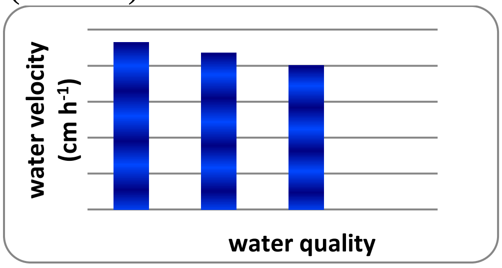


Figure (13): Effect of water quality on velocity of water values (cm $h^{-1}$) of treatments without Bitumen. RLSD at (P > 0.01) = 2.2.

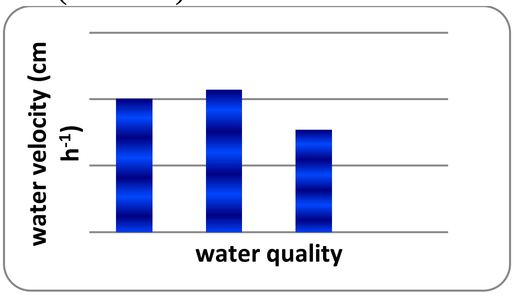


Figure (14): Effect of water quality on velocity of water values (cm $h^{-1}$) of treatments with Bitumen. RLSD at (P > 0.01) = 2.1.

Moreover, the total mean values of water velocity for the treatments without Bitumen application exhibit large decrease in trend with the increase in time of measurement (Figure 15). The highest and lowest values were 78.41 and 0.55 cm $h^{-1}$ at the start and end time of measurement, respectively .The RLSD value (3.5)

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indicated significant differences at P=0.05 in water velocity values with time of measurement.

In general, there are large decreases in values of water velocity with the increase in time of measurement (Figure 16). The highest (25.42 cm $h^{-1}$) and lowest (o.48 cm $h^{-1}$) values were recorded at the second and at the finishing time of measurement; the other values were ranged between these two values. The water velocity values indicated significant differences between time of measurement (RLSD = 5.02 at P=0.05).

T-test for the water velocity values of the treatments without and with Bitumen indicated significant differences between the experiment treatments (T-test=8.16). This can be attributed to the positive effect of Bitumen as an amendment for stabilizing soil aggregates, which in turn, could assist in the control of salt and water movement in the soil.

The choices of Bitumen to be used as a soil amendment and an inhibitor for upward movement of salts in water by capillarity, however, need to be made in accordance with the soil texture class to be treated, level of salinity of water table and the specific conditions prevailing in the field.

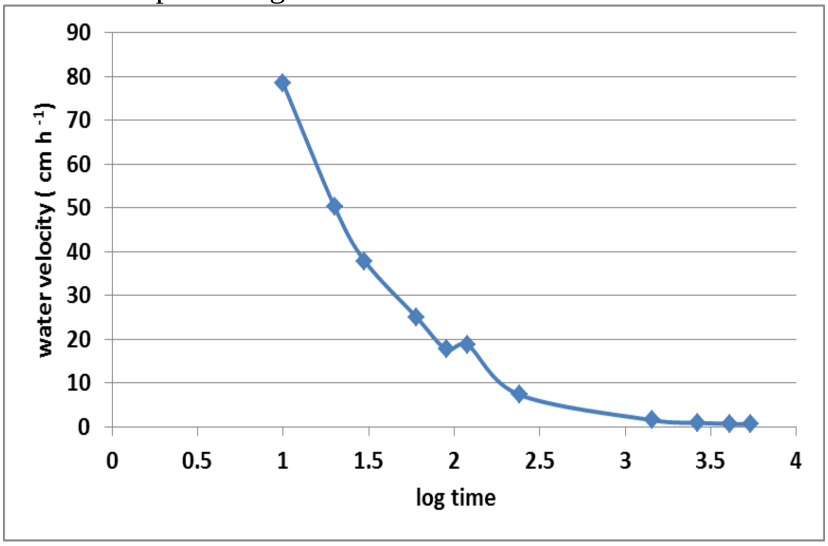


Figure (15): The relationship between time of measurement (log time) in minute and values of water velocity (cm $h^{-1}$) of treatments without Bitumen. RLSD at (P> 0.01) = 3.5.

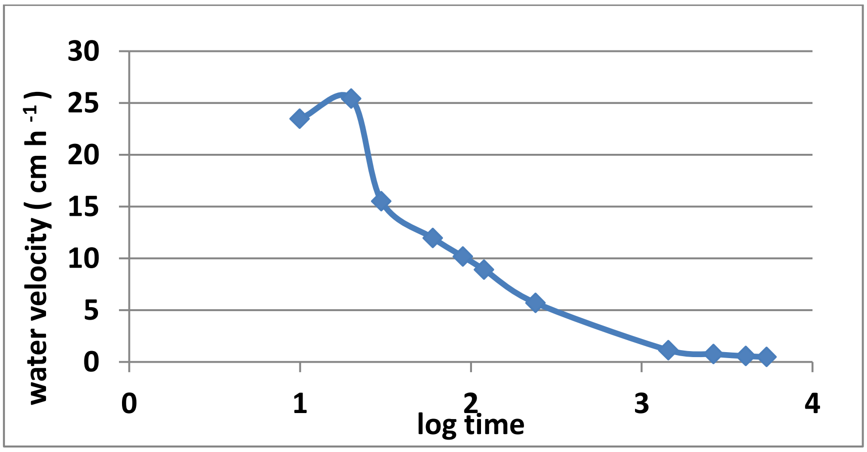


Figure (16): The relationship between time of measurement (log time) in minute and values of water velocity (cm $h^{-1}$) of treatments with Bitumen. RLSD at (P> 0.01) = 5.02.

## Conclusion

The results concluded that:

**1.** The direct effect of Bitumen emulsion in improving soil structure and pores size distribution caused a reduction in upward movement of saline water by capillary action, which resulted in great and small variations in water velocity values between soil textures as well as between water quality treatments, respectively.

**2.** The effect of high concentration of salts on water movement was limited due to the active effect of Bitumen emulsion in improving soil structure and altering pore space sizes (macro pores to micro pores or the vice versa) dependent on the soil texture.

**3.** These results can lead to the hypothesis that the electrical conductivity of water table at the threshold level for a variety of soil textures can be used as a general guide for selecting the right concentration and type of conditioner in order to solve the accumulation of salts on soil surface or limit the effect of capillary action in rising and carrying salts in water from water table to the plant root zone in top of the soil profile.

**4.** These assumptions need further laboratory and field investigations in order to solve the main problem of salts accumulation in the soil profile which has negative influence on soil properties and plant production in the arid and semiarid regions.

## Reference

1- Hillel, D. (1980). Fundamentals of soil physics. Academic press , New York ,London. PP 624.

2- Hillel, D. (2000). Salinity management for suitable irrigation integration science, environment, and economics. The international bank for reconstruction and development. Washington, D.C, 20433, USA.

3- Gradienko, U. P. (1977). Some patterns in the movement of soil water along capillaries. Soviet soil Sci. 9: 632.

4- Matyn, M. A.; Tayel, M. Y.; Wahba, S. A. and Abd Hady, M. (1990). Effect of Bitumen mulch on growth of garlic under different field conditions. Soil Technology, 3: 63-81.

5- El-Hady, O. A.; Ghaly, N. F.; and Wanas, Sh. E. (2008). Hydrophobic–hydrophilic combination for sandy soil conditioning and plantation. 1- Growth response and water and fertilizers use efficiency by Casuarina trees. American Eurasian J. Agric. and Environ. Sci. 4(3): 332-342.

6- Al-Omran, A. M.; Falatah, A. A.; Shalaby, A. A.; Mursil, M. M.; and Nadium M. A. (2002). Application of natural and synthetic soil conditioners for water conservation in calcareous sandy soil. J. Coll. Agric.; King Saud Univ., 14:1, 101 – 111.

7- Mamedov, A. I.; Beckmann, S.; Huang, C. and Levy, G. J. (2007). Aggregate stability as affected by polyacrylamide molecular weight, soil texture, and water quality. Soil Sci. Soc. Am. J. 71(6): 1909-1918.

8- Asghari, S.; Neyshabouri, M. R.; ABBASI, F.; Allasgharzad, N. and Oustan, S. (2009). The effects of four organic soil conditioners on aggregate stability, pore size distribution, and respiration activity in a sandy loam soil. Turk J. Agric. For. 33: 47-55.

9- Gohari, A. A. and Amiri, E. (2011). Effect of water infiltration to soils in increasing yield and under use efficiency in Peanut. J. American Science; 7(6): 678-682.

10- Trautmann, N. M.; porter, K. S.; Wagenet, R. J. (2012). Water and the soil. Natural Resources Cornell Cooperative Extension, Cornell University.

**11-** Al-Atab, S. M. (2008). Variations of soil properties and classification of soils Basrah governorate. Ph.D. thesis, University of Basrah.

12- Al-Darby, A. M., Al-Omran, A. M.; El-Shafei, Y. Z. and Shalaby, A. A. (1996). Influence of highly swelling gel-forming conditioner (Acryhope) on hydro physical properties of layered sandy soils. J. King Saud Univ. (Agric. Sci.) 8(1).

13- Songsri, P.; Jogloy, S.; Holbrook, C. C.; Vorasoot, N.; Kesmala, T. C.; Akkasaeng, C. and Patanothai, A. (2009). Association of root specific leaf area and SPAD chlorophyll meter reading to water use efficiency of peanut under different available soil water. Agricultural Water Management, 96: 790 – 798.

14- Gabriels, D. (1975). The use of Bitumen emulsion as soil conditions. Med. Fac. Landboume. Rijksunir. Cent. 40: 1399-1407.

15- Kalkman, J. (1999). Investigations on the stability of Bitumen emulsions. MSC. Thesis University of Queensland, Bulwer Island.

Page, A. L.; Miller, R. H. and Keeney, D. R. (1982). Methods of soil analysis, Part (2) 2nd ed. Agronomy G., Wisconsin, Madison. Amer. Soc. Agro. Inc., Publisher.

16- Pidwimy, M. and Jones, S. (2006). Infiltration and soil water storage. Fundamentals of physical Geography, 2nd ed. University of British Colombia, Okanagan.

17- Al-Hadi, S. S and Al-Atab, S. M. (2005). The effect of soil aggregate size, irrigation and Bitumen treatments on soil water movement. Iraqi J. Agric. 10(2): 32-42.

18- Al-Hadi, S. S. and Salman, R. F. (1998). Using Polyacrelic acid, Bitumen and organic matter in improving of the soil aggregate stability. Iraqi J. polymers. 2(1): 103 -112.

19- Ajwa, H. A. and Trout, T. J. (2006). Polyacrylamide and water quality effects on infiltration in sandy loam. Soil sci. Soc. Am. J. 70: 643-650.

20- Bryan, R. B. (1992). The influence of some soil conditioners on soil properties: Laboratory tests on Kenyan soil samples. Soil Technology. 5: 225-247.

21- Sadegian, M.; Neyshabori, M. R.; Jafarzadeh, A. A. and Tourchi, M. (2006). Effect of three soil conditioners on the physical properties of soil surface layer. Iran J. Agric Sci. 37: 341-351.

22- Watson, J.; Leland H.; Tom, c.; Susan C.; ED M.; and Carl P. (1995). How water move through soil. Cooperative Extension College of Agriculture. The University of Arizona, Tucson, Arizona 85721.

23- Sen, K. K. and Bhadoria, P. B. S. (1987). The effect of soil conditioners on water movement through lateritic sandy loam soil. Agronomy and Crop Science. 159: 241-244.

**تأثير اضافه مستحلب البتيومين في حركه المياه بالخاصيه الشعريه في ترب مختلفة النسجة**

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**المستخلص**

لبحث امكانية تقليل التأثير الضار لحركه المياه المالحه بالخاصية الشعريه في تدهور بناء الترب وتراكم الاملاح على سطوحها, اجريت تجربه لتقييم تأثير أضافه مستحلب البتيومين على ميكانيكية حركة نوعيات مختلفة من المياه بالخاصيه الشعرية في ثلأث ترب مختلفه النسجه ( طينيه, مزيجه رمليه و رمليه) مجففه هوائيا وممرره من خلال منخل قطر فتحاته 2 ملم. تم خلط نصف كل تربة جيدا بمستحلب البتيومين بتركيز 1% على اساس وزنها الجافه وترك النصف الأخر بدون معامله. عبئت الترب في (54) انبوب زجاجي بطول (100) سم و قطر (0.8) سم. كما استخدمت ثلاث نوعيات من المياه (ماء حنفيه 1.85 $dS\ m^{-1}$, وماء خلط 6.22 $dS\ m^{-1}$, وماء بزل 10.48 $dS\ m^{-1}$), وكررت جميع المعاملات ثلاث مرات. قيس ارتفاع الماء الشعري (سم) خلال زمن القياس (بالدقيقه) وحسبت سرعه ارتفاع الماء الشعري (سم ساعه$^{-1}$) لكل المعاملات (بتيومين, تربه ونوعيه مياه), ثم حللت جميع البيانات أحصائيا بأستخدام البرنامج الأحصائي SPSS.

اظهرت نتائج الخاصيه الشعريه عند ستخدام مياه الحنفيه والخلط والبزل, اختلاف في قيم الارتفاع الشعري لنوعيات المياه مع اختلاف معاملات التربه والبتيومين. اذ ان زياده تركيز الاملاح في الماه سبب انخفاضا معنويا في الارتفاع الشعري خلال فتره التجربة و لجميع المعاملات. كما أشارت النتائج الى ان اضافه مستحلب البتيومين للترب سبب انخفاضا كبيرا في قيم الارتفاع الشعري التجميعي وكذلك في قيم سرعة حركة الماء الشعري للترب المختلفة عند بدايه ونهايه فتره القياس ولجميع المعاملأت, اذ بلغت قيم نسب الانخفاض 70.08 % عند البدايه و 12.66% عند نهايه فتره القياس. أوضحت النتائج أن تغليف مستحلب البتيومين لدقائق التربة من الخارج ونفاذه في داخل تجمعاتها وما تبعه من تحسن في وحدات بناء ومسامية الترب لم يتأثر بالمستوى الملحي الموجود في الماء المرتفع بالخاصيه الشعريه في التربة. اذ سبب البتيومين في ارتفاع نسب الفراغات المسامية الكبيرة (المسامات البزلية) على حساب الفراغات المسامية الصغيرة (المسامات الشعرية) مما ساعد في خفض سرعة ارتفاع الماء المالح بالخاصية الشعرية في جميع الترب.

**الكلمات الداله:** اضافه مستحلب البتيومين, نوعية المياه, ارتفاع الماء الشعري, سرعة الماء الشعري, نسجة التربه.